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Subject 706-D MANUAL OF OPERATIONS

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INTRODUCTION

The information in this manual has been compiled as a matter of record. Various sections have had various authors and no attempt has been made to arrive at a single editorial style.

The compilation of this manual has taken almost a year during which time numerous operating changes have been made. This edition, with minor exceptions, represents operations as they are now carried out. It is expected that from time to time revisions will be made.

Acknowledgement is made to L. R. Michener who started the job of editing this work; also to R. S. Pressly, J. R. Farmakes, A. H. Rom, J. C. Kaskie, S. A. Reynolds, J. N. Butler, J. E. Collier, W. J. Skraba, S. J. Rimshaw, M. Levenson who authored various sections.

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SAFETY

SAFETY

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This document consists of 114 pages
and 15 figures. No. 9 of 12
copies. Series A.

706-D MANUAL OF OPERATIONS

SAFETY RULES

1. "Clinton Laboratories - General Safety Rules" as adopted by the Central Safety Committee (1/27/44) are in effect.
2. "Rules and Procedures Concerning Radioactive Substances and Associated Hazards" as adopted by the Central Safety Committee (9/27/46) are in effect.
3. All additions or alterations to the above safety rules are also in effect.
4. 706-D Operating Areas are the entire building, with exception of the locker-room area and offices.
5. Protective clothing to be worn in the building consists of safety shoes and coveralls. In warm weather slacks and "T" shirts may be used instead of the coveralls. At the discretion of 706-D supervision, rubbers are to be worn in the operating area. These rubbers are not to be worn into the locker-room, toilet, offices or outside the building.
6. The clothing mentioned in (5) must never be worn into the Cafeteria, or in any area marked "KEEP OUT WITH CONTAMINATED MATERIALS OR CLOTHING". Exceptions: Chemists may enter 706-C counting room.
7. Underclothing and socks will be provided. Personal property may be worn instead; however, in case such personal property becomes contaminated, it must be sent to the plant laundry.
8. All visitors must be escorted through the building. Protective clothing will be made available for the visitors and the use of same will be recommended by the escort if need arises. In case personal clothing becomes contaminated, it must be sent to the plant laundry at the owner's risk.
9. Anyone setting off the "friskors" alarms must go to the decontamination room, put the contaminated clothing in bin provided and effect decontamination necessary until the "frisker" will admit them to the locker area.
10. Contaminated clothing must be removed as soon as contaminated is established. Clothing suspected of contamination must be monitored at once.

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SECRET

SAFETY RULES

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11. In the change rooms, worn coveralls must not be put into the lockers but must be hung on the hooks outside each locker. At the end of the shift, the worn coveralls must be deposited in the dirty laundry room.
12. *PERSONALLY OWNED PRESCRIPTION GLASSES* Safety glasses or ~~face shields~~ *OPERATING AREA* are to be worn throughout the ~~building~~ *EXCEPT AS PROVIDED IN RULE #13.* except in offices and locker room.
13. Face shields and rubber gloves are to be worn when handling corrosive liquids.
14. Hands must be washed and counted before eating or leaving the plant.
15. No food or beverage may be brought into the building. Lunches may be eaten only in approved lunch rooms and may be kept only in approved areas in 706-A, 101, 102, 105, etc.
16. All sensitive waste which cannot be disposed of in the hot drains is to be deposited in the red disposal cans provided.
17. Casual or unnecessary personal traffic between 706-C and D working areas is discouraged, and doors between the two buildings are to be kept closed, except when in actual use, in order to reduce the exchange of contamination. Transfer of equipment between the two buildings is prohibited except for the common use of counting equipment, and except as approved by the supervision of both buildings.
18. The 706-C counting room shall be used for counting only. No samples are to be stored in it, no sample preparation is to be done in it, and no equipment or materials are to be taken in except those needed for counting.
19. No person assigned to one building is to enter the operating area of the other without contacting supervision of the building entered.
20. Maintenance personnel may wear their own protective clothing in 706-D if they so desire. If they become contaminated, replacement clothing will be supplied. Rubbers need be worn only at the direction of 706-D supervision.
21. These safety rules apply to anyone in 706-D, regardless of status, ie, visitor, 706-C personnel, etc.

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SPECIAL EXPOSURE RULES

To eliminate the possibility of overexposure to personnel working in "hot" areas, the following rules have been set up:

- (1) The working time in contaminated areas is to be calculated on the basis of 50 mr total to any part of the body. A person who has been exposed to the 50 mr, is permitted to work in the building on other jobs providing that he is exposed to no more than an additional 20 mr due to building background.
- (2) No part of the body is to be knowingly exposed to radiation levels exceeding 6 r/hr (tolerance time - 30 seconds). In case of an emergency involving the safety of personnel this rule may be abrogated by the supervisor in charge. In such instances a full written report will be required within 24 hours.
- (3) If an object reading 6 r/hr is to be handled, it is the responsibility of the supervisor to plan the entire job from removal to burial so as to assure the fact that no one must enter fields of 6 r/hr. The plan of attack must be complete before the job is started.

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TRASH DISPOSAL - 706-D

To relieve the confusion which has existed concerning trash disposal, the following rules have been established:

Trash (any non-liquid waste or scrap material which contains no activity)

Material conforming to the above definition is to be placed in the trash station either in the trash box or in covered yellow cans. It will be picked up on a regular schedule by the Maintenance Department. Should large quantities of trash need to be disposed of, call Mr. Lowe at 6234 to make arrangements for a special trip.

Contaminated Trash (any non-liquid waste or scrap material which, when fully enclosed in a container, reads no more than 100 mr/hr at 1 foot)

Material conforming to the above definition is to be placed in the trash station in covered red cans only. It will be picked up at 1:00 P.M. each day by the Maintenance Department, at time of pick-up a survey must be made by the 706-D Health Physics group.

Emergency Trash (any non-liquid waste or scrap containing activity which either is of such dimensions that it cannot be put into a covered red can, or contains so much activity that the reading at 1 foot is greater than 100 mr/hour)

Material conforming to the above definition is to be placed in a red can or expendable box. An emergency repair order is to be called in to 6142 and Mr. Lowe notified on 6234. Allow maintenance as much notice as possible on all such orders. A member of the 706-D Health Physics group must survey all such material just before pick-up and must personally accompany any material which reads over 500 mr/hr at 1 foot.

Emergency Trash (Shifts) (Same definition as item 3)

Call in emergency repair order to 6142 and contact Maintenance shift foreman. Health Physics coverage will be provided from 706-D. Material must be dumped into a trench in the burying ground but need not be covered unless Health Physics directs.

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Case solution 4.5 liters
at 1.9 M H_2CO_3
Dilute to 20 liters
at 0.5 M H_2CO_3

6) Strong abdominal cramps
and loose stools

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— save food of 2. living

IN SERVICE OF CONSCIENCE
AND HUMAN RIGHTS

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MECHANICAL CASE	2/29	2000
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Adjust concentration of H₂O₂ to make the total 50 cc from 50 cc. & liter 500 ml.

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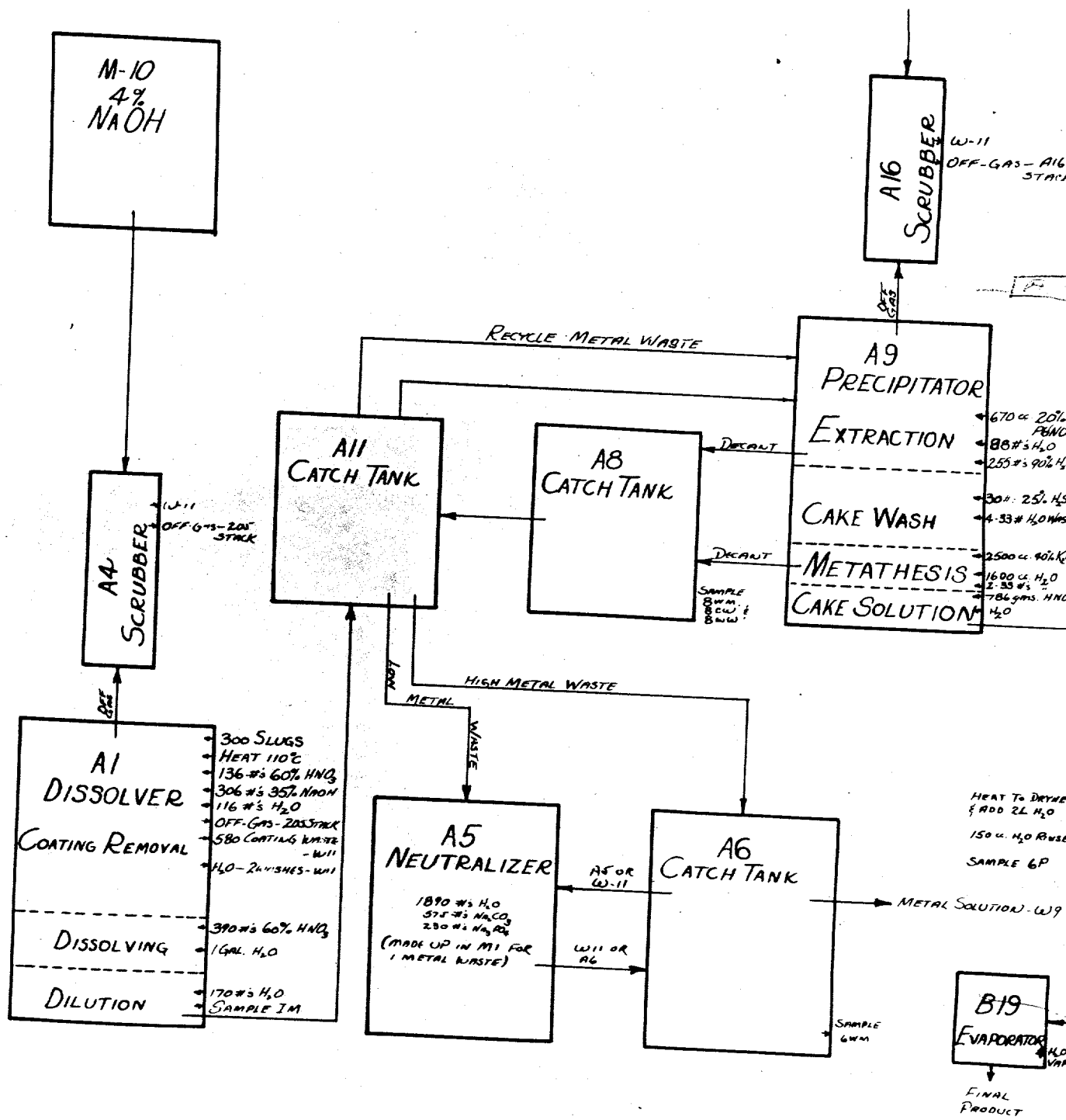
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THE UNIVERSITY OF CHICAGO

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CHEMICAL FLOWS

~~SECRET~~

PRODUCT SPECIFICATIONS

1. The material shipped should be solid BaCl_2 , obtained by evaporation of an almost neutral aqueous BaCl_2 solution.
2. The total weight of Ba must be less than one gram.
3. The product must contain between 1500 and 2500 Curies of active Ba^{140} .
4. The amounts of impurities listed below must not exceed the weights given:

Fe -- 10 mg	Pb -- 50 mg
Cr -- 5 mg	Sr -- 50 mg
Ni -- 5 mg	

DESCRIPTION OF CHEMICAL PROCESS

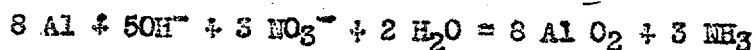
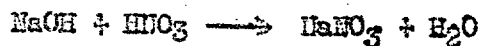
Coating Removal

The uranium slugs which are received from the pile have been "canned" in aluminum. During similar operations in the 205 area, the aluminum jackets were dissolved in 10% HNO_3 with Hg^{++} and NaNO_3 as catalysts. The uranium slugs are slightly soluble in 10% HNO_3 and thus there resulted a 1.0% to 1.5% loss of product in the coating removal solution. The method used in 706-D is to dissolve the aluminum with NaOH with NaNO_3 used to convert H_2 to NH_3 . Uranium is not as soluble in 10% NaOH as in 10% HNO_3 .

Before the slugs are loaded into the dissolver, or during the time of loading slugs, 35% NaOH is placed in the dissolver and neutralized with 60% HNO_3 to give NaNO_3 of final concentration of 12.5%. After all the 300 odd slugs have been loaded into the dissolver, the coating removal operation is continued by adding 35% NaOH to make a final concentration of 10% NaOH .

The concentration of NaNO_3 must be kept above 10% to prevent the formation of $\text{Al}(\text{OH})_3$ on the sides of the slugs which will render the surface passive toward further chemical reaction with NaOH .

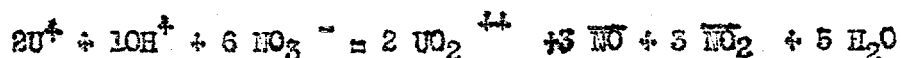
The chemical reactions are:



The reaction between aluminum and sodium hydroxide starts at room temperature but the solution is heated to 100-105°C for one hour as the reaction is much more rapid at that temperature. After one hour the coating removal solution is diluted, cooled and sent to the waste tank. The dissolver is washed twice with water.

Dissolving

To the uncoated slugs in the dissolver is added 390 pounds of 60% HNO_3 which is sufficient nitric acid to dissolve 65 slugs. This solution is heated to 105-115°C until the specific gravity of the solution reaches 1.78 \pm .02. The resultant 70% UMH will freeze at about 50°C so it is diluted with 170# H_2O keeping the temperature above 80°C. The final specific gravity of 1.55 corresponds to 50% UMH.



As shown by the chemical equation, NO and NO_2 gases are evolved which at the beginning of the reaction causes the apparent specific gravity of the reacting HNO_3 to drop below 1.0.

Extraction

The extraction process is a precipitation of PbSO_4 , used as a carrier for the BaSO_4 which is present in amounts far too small to precipitate alone. Lead and barium are precipitated as insoluble sulphates forming mixed crystals in all proportions.

During the development of the chemical process various deviations were made from flow sheet conditions such as varying (1) the amount of lead added (2) the H_2SO_4 concentration and temperature of slurry during acid addition (3) the UMH concentration and (4) the time of settling.

The optimum condition for extractions which were found and used at present are summarized as follows:

(1) 150 gm $\text{Pb}(\text{NO}_3)_2$ is added as carrier in a 65 slug extraction. Amounts in excess of 150 gm interfere with complete removal of the lead in the electrolysis cell later in the process. The use of less than 150 gm results in incomplete precipitation of Ba^{140} .

Approximately 20% (30g) of the 150g $\text{Pb}(\text{NO}_3)_2$ which is used in the first batch is lost in decantation and must be replaced in each subsequent batch.

(2) 355 lbs. of 65% H_2SO_4 is added over a 30 minute period, while the extractor is kept at a temperature of 80°-90°, to give 3.5M H_2SO_4 concentration in final slurry. The slurry is digested for 1 hour, settled for 3 hours hot, then settled for 5 more hours at approximately 30°C, and then decanted.

The 65% H_2SO_4 , used in this process, was chosen because weaker acid would decrease the slug capacity of the extractor, while the use of stronger H_2SO_4 was found to interfere with the settling and decanting qualities of the slurry.

The concentration of 3.5M H_2SO_4 in the final slurry was chosen because concentrations under 3.0M increased the solubility of the extraction precipitate and increase the product loss in the extraction waste.

The 80°-90°C temperature during acid addition, digestion and first three hours of settling and the 1/2 hour period acid addition are used for complete and large crystal growth.

The 8 hour total settling period is probably more than adequate for complete settling but no attempt has been made to decrease it since other difficulties have been encountered in extraction separations and it was inadvisable to decrease the settling time until the other sources of trouble were corrected.

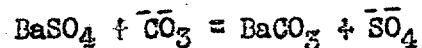
Extraction Washes

The combined extraction cake from all batches is washed first with 25% H_2SO_4 and then four times with water.

The H_2SO_4 removes the UHM left with the cake after the last decantation. The water washes complete the removal of UHM and remove the H_2SO_4 . Incomplete removal of the H_2SO_4 will interfere with the metathesis step which directly follows extraction.

Metathesis

Lead sulphate and barium sulphate being insoluble must be metathesized to the carbonate.



The process consists of (1) adding at 85°-95°C, 2500 ml 4M K_2CO_3 to the extraction cake to give the slurry a K_2CO_3 concentration of approximately 2M (2) diluting with water over a 30 minute period at the same temperature to give .5M K_2CO_3 (3) digesting at the same temperature for 30 minutes (4) cooling to 30°C over 30 minute period (5) settling for 2½ hours and (6) decanting. The entire process is repeated to insure complete conversion.

While the concentration of K_2CO_3 before dilution is 2M, the reaction takes place, PbCO_3 and BaCO_3 remaining in solution. Diluting it

with water causes the PbCO_3 and BaCO_3 to precipitate. The 30 minute digestion period and slow cooling brings about complete precipitation and large crystal growth. Incomplete reaction from sulfate to carbonate will result in high product loss when the metathesis cake is dissolved for transfer to electrolysis.

Metathesis Wash

The metathesis cake is washed twice with water to remove excess K_2CO_3 . Incomplete removal of K_2CO_3 was found to interfere with the operation of stationary pipettes after evaporation volume reduction later in the process due to formation of crystalline KNO_3 .

Electrolysis

The metathesis cake is dissolved in the extractor in sufficient HNO_3 and water so that when transferred to the electrolysis vessel, the solution is approximately 3.0M in HNO_3 and the volume approximately 4 liters. The transfer is made through a sintered glass filter disc to remove foreign insoluble material collected in the extractor which may interfere with the operation of equipment and add impurities which must be removed later in the process.

This nitric solution which contains Pb^{++} , Cr^{+++} , Fe^{+++} , Ni^{++} and Ba^{++} , is electrolyzed three hours at 15 amperes and then seven hours at 25 amperes. The lead and small amounts of Fe^{+++} and Ni^{++} are deposited on the platinum gauze (cathode). Agitation of the solution during electrolysis results from the interaction of the electric and magnetic fields. The magnetic field is furnished by strong permanent magnets outside of the vessel.



The amount of lead remaining in solution after electrolysis should be less than 500 mg, since further removal of lead in subsequent steps is limited and the resulting product may exceed the lead specifications. An excessive amount of lead will also prevent a complete removal of lanthanum in the fuming nitric precipitation later in the process. This lanthanum, which is a strong gamma emitter, will cause polymerization of the ether in the HCl -ether extraction.

Volume Reduction

After electrolysis, the solution which is now essentially $\text{Ba}(\text{NO}_3)_2$ plus impurities, is transferred to a conical shaped tank and evaporated to dryness. Two liters of water are added and the solution again evaporated to 350 ml.

The evaporation to dryness before evaporation to the desired volume of 350 ml is used to remove all the HNO_3 which is present as 70% acid near the end of the first evaporation. This acid throws the $\text{Ba}(\text{NO}_3)_2$ out of solution and makes the transfer of product out of the vessel almost impossible.

At the end of the evaporation to dryness, care must be taken to prevent excessive heating of the dry precipitate since a part of it may be blown into the off-gas system by the air sweeping through the vessel.

Ba(NO₃)₂ Precipitation

The 350 ml solution which contains the Ba(NO₃)₂, La(NO₃)₃, Sr(NO₃)₂ and impurities of lead, chromium, iron and nickel, is transferred to the glass equipment and the vessel rinsed with 150 ml water. The glass equipment is used at this stage of the process to eliminate further contamination of the product with metals from stainless steel.

2500 ml fuming nitric is added to solution to precipitate the Ba¹⁴⁰ as Ba(NO₃)₂. La(NO₃)₃ and the impurities of lead, chromium, iron and nickel which are soluble in strong HNO₃ are filtered out as waste in the filtrate. The ratio of HNO₃ to the original volume of Ba(NO₃)₂ solution is kept at 5 to 1 (above 15M HNO₃) to prevent the Ba(NO₃)₂ from going into solution.

To insure a more complete removal of impurities this process is repeated by dissolving the cake in 50 ml water and reprecipitating the Ba(NO₃)₂ in 1500 ml fuming HNO₃.

HCl-ether Extraction

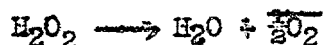
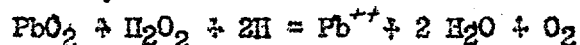
The crystals of barium and lead nitrate are dissolved in 50 cc of distilled water. To this solution is added 500 cc of HCl-ether solution (5 vol. HCl/vol. ether). The BaCl₂ is insoluble in HCl-ether and precipitates as the chloride. The strontium, and possibly some remaining lanthanum, remain in solution as chlorides and are filtered out as waste.

After washing the barium chloride crystals with alcohol-HCl solution, (96 cc alcohol + 4 cc HCl) to remove HCl-ether waste, and 3 ether washes, to remove all HCl., the precipitate is redissolved in 100-150 ml H₂O, sampled, and finally evaporated in a small tantalum or platinum lined shipping cone.

WASTE DISPOSAL

The acid waste from extraction is neutralized with Na₂CO₃ - Na₃PO₄ solution in ratio 3.75 volumes of carbonate-phosphate solution per volume of waste solution. The Na₃PO₄ is used to keep U in solution. The neutralized waste solution is in Na₂CO₃.

The lead oxide remaining on platinum gauze after electrolysis must be removed by H₂O₂ in the presence of HNO₃.



All other wastes, except those used for extraction of by-products are neutralized with NaOH and disposed of to the tank farm.

There are about one hundred and fifty different isotopes contained in the uranium slugs which come from the pile but only some of the isotopes of xenon, iodine, strontium, barium and lanthanum are occasionally removed from the process as wastes and delivery to 706-C building for further separation and purification of radioisotope products.

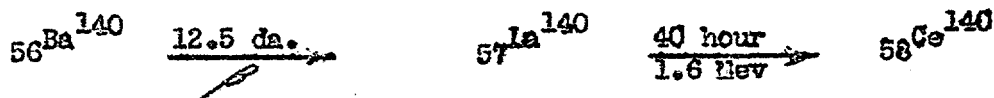
Iodine

Some radioactive iodine, the half life of which is partially determined by the age of the slugs at the time of dissolving, escapes as a gas through the dissolver condenser during the dissolving operation and is condensed in the line between the condenser and scrubber. This condensate is collected in a pot located where the gases enter the scrubber.

The condensate is removed from the pot through a pipe leading from the pot through the cell wall by applying vacuum to the line through a carrier assembled for that purpose.

Lanthanum

Ba¹⁴⁰ decays with a 12.5 day half life to La¹⁴⁰ which is a source of high gamma radiation. This La¹⁴⁰ is contained in the fuming HNO₃ waste which can be removed from the cell by the following procedure: (1) evaporate waste to dryness in B-6, (2) dissolve cake in 2 liters water, (3) repeat evaporation to 250 ml, (4) transfer to product cone and evaporate to dryness and (5) ship in cone in regular final product carrier.



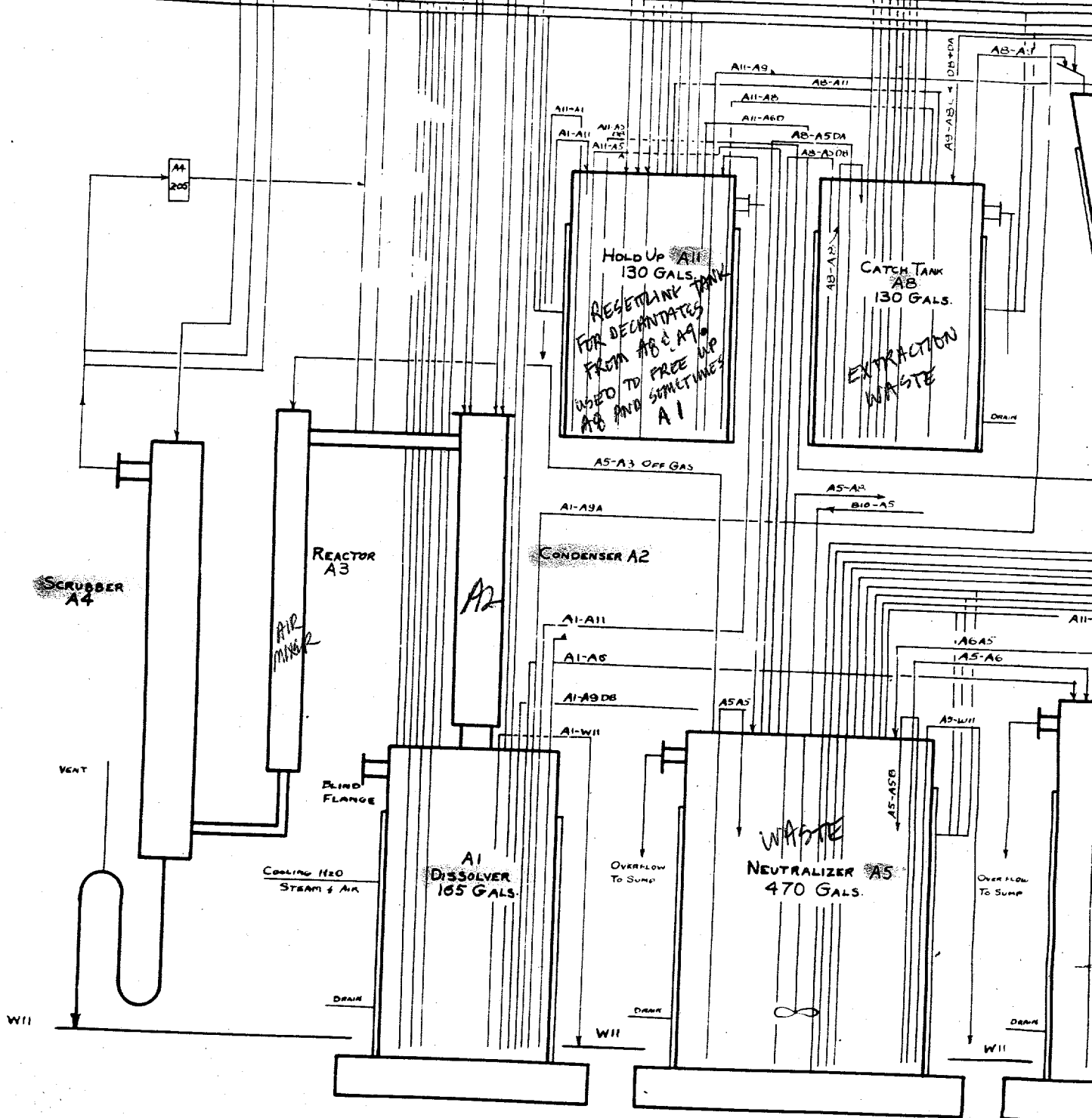
Strontium

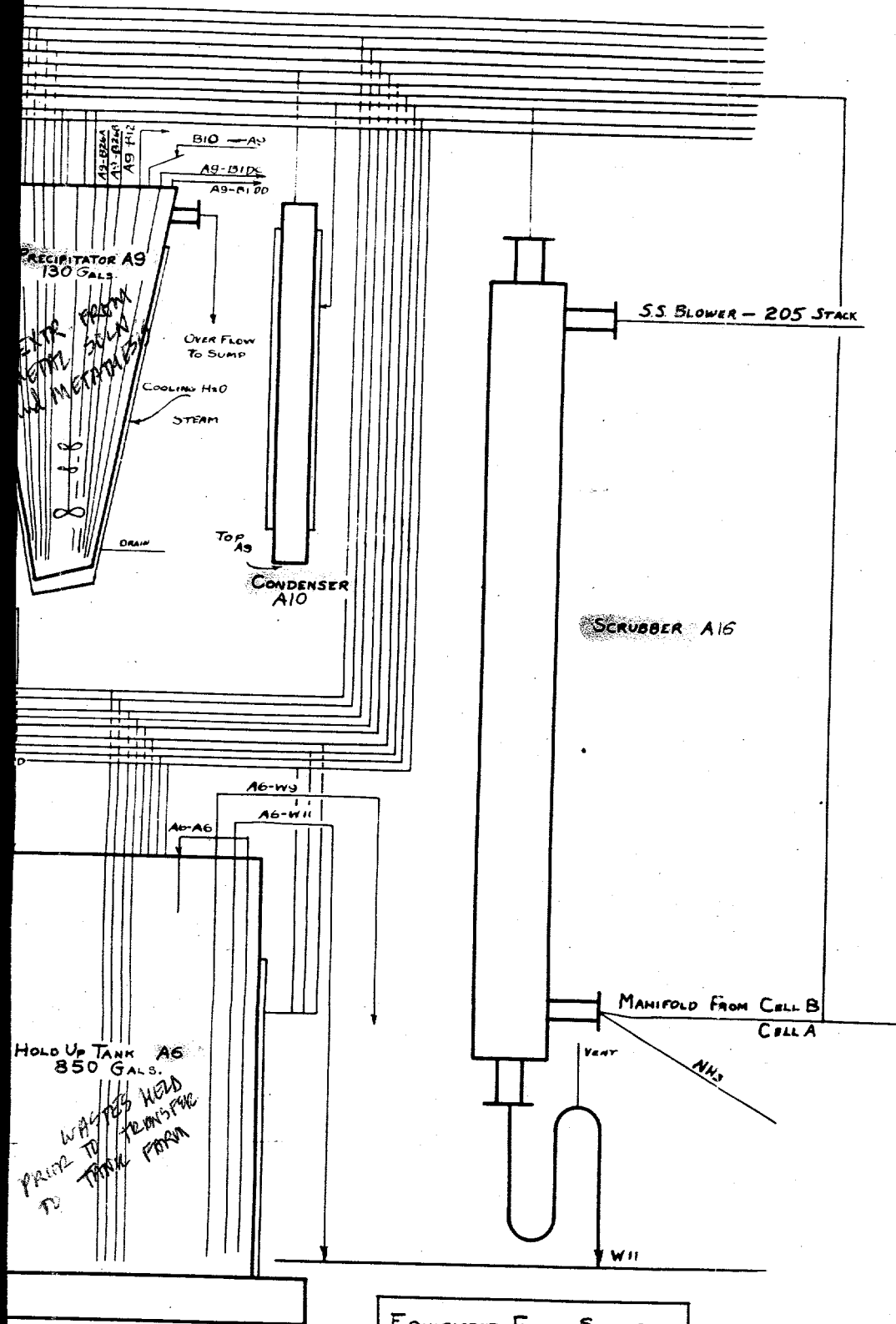
Strontium, a weak beta emitter of 55 da. half life, is soluble in the HCl-ether solution. The HCl-ether waste can be discharged from the glass equipment directly into special carrier which is then sent to 706-C building for strontium extraction.

Radioactive Xenon

Radioactive xenon is one of the fission products from the slugs. By a process of absorption in charcoal, it can be separated from the gases discharged to the 205 stack.

DRAIN TO SETTLING BASIN
LOW MEASUREMENT
TEMP MEASUREMENT
PRESSURE
LIQ LEVEL + 5A IR
SAMPLE LINES
OFF GAS TO SCRUBBER A-1
AIR IN
COOLING WATER
SOLUTIONS
STEAM





EQUIPMENT FLOW SHEET
 CELL A BLDG 706 D
 MONSANTO CHEMICAL CO.
 CLINTON LABORATORIES
 DRAWN BY WJS. DATE July 31, 1946
 DWG. No P4

CELL A EQUIPMENTDissolver A-1

The dissolver is a 165 gallon, 25-12 stainless steel cylindrical, jacketed tank mounted on a concrete pad in the S.E. corner of Cell A (CL-706D-67). The inside of the tank is lined with baffles which protect the wall and service piping during slug loading.

A slug chute (for details see Print CL-706D-128), through which the slugs are charged into the dissolver, is a 3" pipe extending from the third floor into the tank through the lid. The chute is curved to prevent direct radiation from the dissolver to the third floor. A crash plate is provided at the exit of the chute to break the fall of slugs to prevent damage to the dissolver.

The dissolver is serviced with vacuum from the A4-205 off-gas system through a condenser (A-2) which is situated on top of the tank. Other services to the tank are listed below:

Services to tank A-1:Jet In (Controls at PB-2):

→ All-A1

Jets Out (All controls at PB-1):

AI-A11 - WASTE

AI-A6 - HOLDUP TANK

AI-A9A PRECIPITATOR

AI-A9B

AI-A11 - HOLDUP TANK

Solution In:

Through two funnels (from tanks T8 and T9)
above Cell A

Sampler:

Standard Type at Wall Plug AS-J3

Instrumentation:

Ring balance liquid level and Sp.Gr. recorder,	PB1-1;
Micromax Temperature recorder,	PB1-2;
Ring balance vacuum recorder,	PB1-5;
Slug microphone and speaker,	PB2-1;
Esterline Angus Slug counter,	PB2-2.

Agitation:

Air and steam sparger (Control at PB-1)

Jacket:

Air, steam, water, vent. (Controls at PB-1)

BIBLIOGRAPHY

- (1) 706-D Analytical Laboratory Manual
- (2) Hume, Glendennin, CN2815-X
- (3) Notebook CLA-222 (S.A.Reynolds)
- (4) 706-D Analytical Procedures
- (5) Hume, Nelson, Boldridge, CL-GDC-No. 5
- (6) Communication from J. E. Hudgens
- (7) Kaskie, Physical Measurements of Radiation from Ba¹⁴⁰ from Run #7.
- (8) Reynolds, Physical Measurements (unpublished DATA)

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Condenser A-2 (Print #CL-706D-68)

The reflux condensor is used to prevent the escape of large quantities of nitric acid vapors into the off-gas system during the dissolving reaction. It is essentially an 8' x 1' 25-12 stainless steel water jacketed pipe with three stainless steel water cooling coils inside the top end.

The services include four water lines, one to the condenser jacket and three to the cooling coils. A thermocouple in one of the exit lines from cooling coils records the temperature of the exit water on PBI-2 micromax while a thermocouple at the top of the condenser records the temperature of the gases leaving A2 to the scrubber A-4.

Description of Reactor A-3

The reactor is a 6" IPS x 8 $\frac{1}{2}$ ' ft. 18-8 stainless steel pipe connecting the condenser A2 and the scrubber A4. It is used as a chamber for mixing the oxides of nitrogen, which escape the condenser A2, with sufficient air, which is introduced through a pinhole in A3, to facilitate the dissolving of these oxides in the caustic scrubber A4.

Scrubber A-4 (Print #CL-706D-70)

The scrubber, which is essentially made of a 9' x 8" I.D., 18-8 stainless steel pipe packed with 1" stainless steel Rashig rings, is used to remove, with 4% caustic, the nitrogen oxides which escape A-1 during dissolving and A-5 during neutralization of wastes from the A4-205 off-gas system.

The vacuum is supplied to vessels A-1 and A-5 through this scrubber by a 2" line running from A-4 to a jet at the 205 stack (for more detailed description, see section on "Ventilation".) In addition to the vacuum line, the scrubber services include the following:

- a) 4% Caustic feed line from tank M10 through pump M3 with rotameter control at PB-1.
- b) Water feed line through rotameter at PB-1.
- c) Waste line to tank W-11.

Neutralizer A-5 (Print CL-706D-71)

The neutralizer, used for neutralization of wastes, is a 470 gallon, 25-12 stainless steel, cylindrical, jacketed tank mounted on a concrete pad along the east cell wall just north of the dissolver A-1. It is equipped with a mechanical agitation driven by a Crocker-Weisler 3 H.P. motor with a Philadelphia Gear Works Motor reducer. This assembly is mounted on top of the tank.

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The vacuum to this tank is supplied by the A4-205 off-gas system which is more adequately described under section on ventilation. Other services to the tank are listed below:

Services to Tank A-5:

Jets In:

A-Sump - A5 (Controls at PB-3)	A8-A5B - (Controls at PB-1)
A5-A5A " " PB-1	A11-A5A - " " PB-2
A5-A5B " " "	A11-A5DB - " " "
A6-A5 " " "	B10-A5A - " " PB-5
A8-A5DA " " "	B10-A5B - " " "
	M1-A5 - " in Make-up Room

Jets Out: (All Controls at PB-1)

A5-A8
A5-W11
A5-A6

Solution In:

Through Funnel (from tank T9) above Cell A.

Sampler:

Standard type at Wall plug AS-J2.

Instrumentation:

Ring Balance Liquid Level and Specific Gravity Recorder,	PB1-11;
Micromax Temperature recorder,	PB1-2;
Pressure-Vacuum Manometer,	PB1-9.

Agitation:

Mechanical, air, steam sparger, 2 circulating jets.

Jacket:

Air, steam, water, vent. (controls at PB-1)

Hold-up Tank A-6 (Frint CL-706D-72)

This tank is used for storage of wastes prior to its disposal to tank farm. It is cylindrical 850 gallon, 25-12 stainless steel jacketed tank. It is mounted on a concrete pad along the east cell wall north of the neutralizer A-5.

The vacuum to the tank is supplied by the A-16-205 off-gas system which is described under section on "Ventilation". Other services to this tank are listed on the following page:

Services to Tank A-6:Jets In:

A5-A8	(Controls at PB-1)
A1-A6	" " "
A6-A6	" " "
A11-A6D	" " PB-2
BS-A8	" " PB-3

Jets Out:

A6-W9	(Controls at Tank W9)
A6-W11	" " PB-1
A6-A5	" " "
A6-A6	" " "

Solution In:

Through Funnel (From Tank T9) above Cell A.

Sampler:

Standard type at Wall plug AS-J1.

Instrumentation:

Ring balance liquid level and specific gravity recorder,	PB1-13;
Pressure-vacuum manometer,	PB1-14.

Agitation:

Air and steam sparger, circulating jet. (Controls at PB-1).

Jacket:

Air, steam, water, vent. (Controls at PB-1)

Catch Tank A-8 (Print OL-706D-100)

This tank is used to receive the extraction waste which is decanted during the extraction process. The waste is sampled here prior to its neutralization and disposal to tank farm.

It is a cylindrical, 25-12 stainless steel, 130 gallon, jacketed tank, mounted on the west wall between A-11 and A9.

The vacuum to this tank is supplied by the A15-205 off-gas system which is described under section on ventilation.. Other services to the tank are listed below:

Services to Tank A-8:Jets In:

A5-A8	(Controls at PB-1)	A9-ASDB	(Controls at PB-2)
A8-A8	" " PE-2	A9-ASB	" " "
A9-ASDA	" " "	A11-A8	" " "

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Jets Out:

A8-A8DA	(Controls at PB-1)
A8-A8B	" " "
A8-A9	" " PB-2
A8-A11	" " "

Solution In:

Two from roof: one large quantity line, (T8, T9) and one smaller quantity line over splash plate.

Sampler:

Standard type through wall plug AT-B3.

Instrumentation:

Liquid level manometer,	PB2-8;
Micromax temperature recorder,	PB2-7;
Pressure-vacuum manometer,	PB2-10;
Specific gravity manometer,	PB2-9.

Agitation:

Steam and air sparger, circulating jet. (Controls at PB-2)

Jacket:

Steam and water. (Controls at PB-2)

Precipitator A-9 (Print CL-706D-102)

The extraction of Ba¹⁴⁰ from the metal solution with H₂SO₄ and the subsequent ~~metathesis~~ synthesis of the BaSO₄ precipitate to BaCO₃ with K₂CO₃ is carried out in this tank. It is a 115 gallon, 25-12 stainless steel, conical, jacketed tank, the dimension of which are 6' high x 2' 10" I.D. at top x 10" I.D. at bottom. The inside wall of the tank is polished to a No. 4 finish to aid in settling of the precipitates.

The services to the tank include a mechanical agitator driven by a shaft extending to a motor and gear reducer located on the third floor directly above A9. The vacuum to the tank is supplied by the A16-205 off-gas system (described under section on ventilation) through the reflux condenser A10. Other services to the tank follow:

Services to Tank A9:

Jets In: (All controls at PB-2)

A1-A9A	A11-A9
A1-A9B	B10-A9
A8-A9	

Jets Out: (All controls at PB-2)

A9-A8DA	A9-B1DC
A9-A8DB	A9-B1DD
A9-A8C	A9-B12
A9-B2GB	A9-B2GA

Solutions In:

1. Through funnel (from tank T8) to bottom of tank.
2. Through funnel (from tank T9) to top of tank above slinger ring.
3. Through funnel near PB-2 to top of tank above slinger ring.

Sampler:

Standard type at wall plug AW-B7.

Instrumentation:

Two liquid level manometers,	PB2-14 & PB2-15;
Specific gravity manometer,	PB2-16;
Micromax temperature recorder (2 points),	PB2-7;
Pressure-vacuum manometer,	PB2-13.

Agitation: (All controls at PB-2)

Mechanical, air and steam sparger.

Jacket: (All controls at PB-2)

Steam and water.

Condenser A-10 (Print CL-706D-109)

A-10 is a reflux condenser mounted on top of A9, used to prevent the escape of some of the vapors from A9 during extraction. It is a $3\frac{1}{2}$ " x 3" IPS water jacketed, 18-8 stainless steel pipe connecting A9 to the A16-205 off-gas system. The water to the jacket is controlled from PB-2. A thermocouple at the exit records the temperature of the exit gases on micromax on PB-2.

Resettling Tank A-11 (Print CL-706D-100)

This tank is used for (1) resettling of high loss decantates received in A8 and A9 while A8 is free to receive another batch from A9 and (2) occasional storage for diluted metal solution to free A-1 to start another dissolving ahead of schedule.

This tank is located in the S.W. corner of the cell, south of A8. The construction of this tank is identical to that of A8.

It is serviced with vacuum from the A16-205 off-gas system (described in section on "Ventilation"). Other services are listed as follows:

Services to Tank A-11:

Jets In:

A1-A11	(Controls at PB-1)
A8-A11	(Controls at PB-2)

Jets Out: (All controls at PB-2)

A11-A1	A11-A9
A11-A5A	A11-A5DB
A11-A8	A11-A8D

Solution In:

One funnel (from tank T8) above Cell A.

Instrumentation:

Liquid level manometer,	PB2-6;
Specific gravity manometer,	PB2-5;
Pressure-vacuum manometer,	PB2-4;
Micromax temperature recorder,	PB2-7.

Agitation: (Controls at PB-2)

Air and steam sparger.

Jacket: (Controls at PB-2)

Steam and water.

Scrubber A-16^m (Print 01-706D-70)

This scrubber is used to remove with H_2O and water the acid vapors and active gases which are drawn into the A16-205 off-gas system from all tanks in Cell A and B except A1 and A5. It is made of a 8' x 14" ID stainless steel pipe packed with 1" stainless steel Rashig rings on top of a grating in the bottom of the vessel.

The vacuum is supplied to the vessels through a 4" stainless steel line connecting the top of the scrubber to a small blower located in the fan house. The water and ammonia are fed through a rotameter at PB-2 to the top of the scrubber and drains through the bottom to W-11. The vessel off-gas enters the side of the scrubber near the bottom and makes its exit on the side near the top. Two manometers at PB-2 give the vacuum reading at the bottom and top of the scrubber.

Sump

The sump is a trench running the full length of the cell along the west wall. It is 12" in width and varies in depth from 4" at the south end to 7" at the north end. The sump, as well as the entire cell floor, is covered with lead to protect the concrete from acids and to prevent absorption of activity in the concrete.

The overflow lines from tanks A5, A6, A8, A9 and A-11 and the drain lines from the sample blisters from tanks A1, A5, A6, A8 and A9 discharge into the sump. Solutions that may overflow from these vessels may be jettted back into tank A5 by a jet line running from the sump to A6 or directly to tank W-11 by a jet line running between the sump and W-11. The controls for these jets are located at PB-3.

Note: The following description will be for a run dissolving 900 slugs to produce approximately 2500 Curies of barium.

Loading

Two lead slug carriers, each having a capacity of twenty-six slugs, are used to transfer the active slugs from the 105 Building canal to the 706-D Building loading chute. During the loading, transporting, and discharging of the slugs, a Health Physics man covers all the operations to ascertain whether the radiation level is above tolerance or not. The slug carrier is removed from the truck and placed over the loading chute by means of the two building hoists. The carrier is discharged by pulling the bottom plate out by means of two long handled cranks. The addition of each slug is recorded on the Esterline-Angus chart and noted by the microphone speaker arrangement. This latter arrangement for counting the slugs introduced into the dissolver is the more reliable method.

Summary of the Process

Nine hundred slugs are loaded into the dissolver in three 300 slug portions to produce approximately 2500 Curies of barium. The three batches of slugs are added just before the first, fourth and ninth metal dissolving.

The aluminum coats on the slugs are removed by selective dissolving after each slug loading. Once the coats are removed, the neutron bombarded uranium slugs are ready for dissolving. The 900 slugs are processed in twelve batches of approximately 65 slugs each with 120 slugs held in a standby position to be used to compensate for some abnormal losses that may or may not occur.

Each of the twelve metal dissolvings are transferred to the extractor. Here the active material is extracted from the solution and is retained in the form of a precipitate while the waste solution is jetted to a catch tank. The waste solution is then transferred to another vessel for resettling and decanting to save any extraction precipitate that may be lost in the first decantation. The next dissolver solution is passed through this resettling vessel on its way to the extractor to pick up the heel from the second decantation. All subsequent batches of the dissolved metal are individually processed through the extraction step after which all material loses its batch identity.

After all of the extraction are completed, the sulfate cake is metathesized to a carbonate which in turn is dissolved in nitric acid and transferred to the electrolytic bath through a fritted glass filter in Cell B. The Cell B process is to purify and concentrate the product.

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Coating Removal

Before the slugs are loaded into the dissolver, 136 pounds of 1.37 ± 0.02 specific nitric acid and 150 pounds of 1.38 ± 0.02 specific gravity sodium hydroxide are added to A-1, the dissolver. The acid line is rinsed with fifty pounds of water and the caustic line with sixteen pounds. With a vacuum of four to eight inches on A-1, 156 pounds of the 1.38 ± 0.02 specific gravity sodium hydroxide are added to the dissolver. The steam is turned on the jacket of A-1 to bring the solution up to reaction temperature, $100-110^{\circ}\text{C}$. The desired vacuum is obtained by regulating the A-5 off-gas valve. The removal of the aluminum coats is completed within thirty minutes after reaching the reaction temperature. The solution of aluminum is jetted to tank W-11 at the tank farm. After the aluminate solution is all removed by rinsing with water, the uranium slugs are ready for dissolving.

Dissolving

Three hundred and ninety pounds of 1.37 ± 0.02 specific gravity nitric acid is added through the scale tank and funnel on the third floor to the dissolver. The scale tank and addition line is rinsed with eight pounds of water. With four to eight inches of vacuum maintained on A-1, heat is applied to raise the solution to reaction temperature, $105-110^{\circ}\text{C}$. This temperature is maintained until the specific gravity of the solution in the dissolver reaches 1.78. To prevent formation of a pressure in the dissolver during this reaction and a consequent backup of activity into the operating area, it is essential that a more than adequate amount of vacuum can be supplied to the dissolver before the dissolving operation is begun. This can be done by keeping the off-gas line free of water.

After the uranyl nitrate hexahydrate, UNH, solution has reached its specific gravity of 1.78, it is diluted with 170 pounds of water while the temperature of the dissolver contents is maintained above 80°C to prevent freeze-up of the undiluted metal solution. The diluted UNH solution is sparged for fifteen minutes. The contents of A-1 is now cooled to 40°C or below. A 0.5 ml sample is now taken for the determinations of uranium, barium, and the number of slugs dissolved. The first two batches of the run are now transferred directly to A9 for extraction while all other batches are transferred to A9 via A-11 to pick up a metal waste heel in A-11.

Extraction

670 ml.* of twenty percent lead nitrate is added to the UNH solution in A-9. The addition line is rinsed with 2 liters of water. Ninety-eight pounds more water is added to the extractor. Over the next thirty minutes 255 pounds at ninety percent sulfuric acid is introduced while the temperature of A9 contents is kept at $80^{\circ}-90^{\circ}\text{C}$. The slow addition of the acids aids crystal growth. The temperature of $80^{\circ}-90^{\circ}\text{C}$ is maintained with

* At end of extraction write-up.

CELL A PROCESS

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the agitator in motion for one hour. The co-precipitate of lead and barium sulfate is allowed to settle eight hours, three hours at 80°-90° and five at 35°C. If the liquor should be cooled to 30°C the UHM solution may freeze and plug up the jets.

The supernatant liquor is decanted as waste to the catch tank A8, and sampled. While awaiting results of analysis of the waste, the solution is jettied to the resettling vessel, A-11, where it is resettled for five hours to remove any precipitate that is lost in the decantation of the waste from A9 to A8. If the sample taken of the waste in A8 indicates a loss less than 50 Curies, the waste is decanted from A-11 into a carbophosphate solution in A5 which neutralizes it. If the sample indicates a loss greater than 50 Curies, the waste is decanted from A-11 to A6 where it is again sampled and analyzed before it is jettied into a carbophosphate solution in A5 for neutralization.

After each decantation from A9 to A8, the following batch of metal solution is jettied on top of the extraction heel in A9 and the extraction and waste disposal carried out in the same manner until the last batch of the run is extracted and decanted. The precipitate is then washed with thirty pounds of twenty-five percent sulfuric acid and four thirty-three pound portions of water. After each washing, the precipitate is allowed to settle for seventy minutes. All washes are decanted to A-8, sampled in A8, neutralized in A5 and sent to the tank farm. The precipitate is now ready for metathesis.

* For subsequent extractions 120. ml of twenty percent lead nitrate is used to make up for the loss in each decanted waste.

Neutralization

The carbophosphate solution used to neutralize the metal waste is made up in the make-up room in tank M-1. 2700 lbs. of this solution is jettied from M-1 to A5 for the neutralization of each batch of metal waste.

The metal waste ready to be neutralized may be in either tank, A-11 or A6, as described under "Extraction". With A5 under maximum vacuum, and with A5 mechanical agitator and jacket water on, the waste is jettied into the carbophosphate solution at a rate slow enough to prevent an extremely fast evolution of gases in A5 which may put the vessel under some pressure and cause the "hot" gases to be discharged into the cell.

When neutralization is complete, the batch is cooled to jetting temperature and transferred to W-9 (metal waste storage tank at tank farm) via A6.

Metathesis

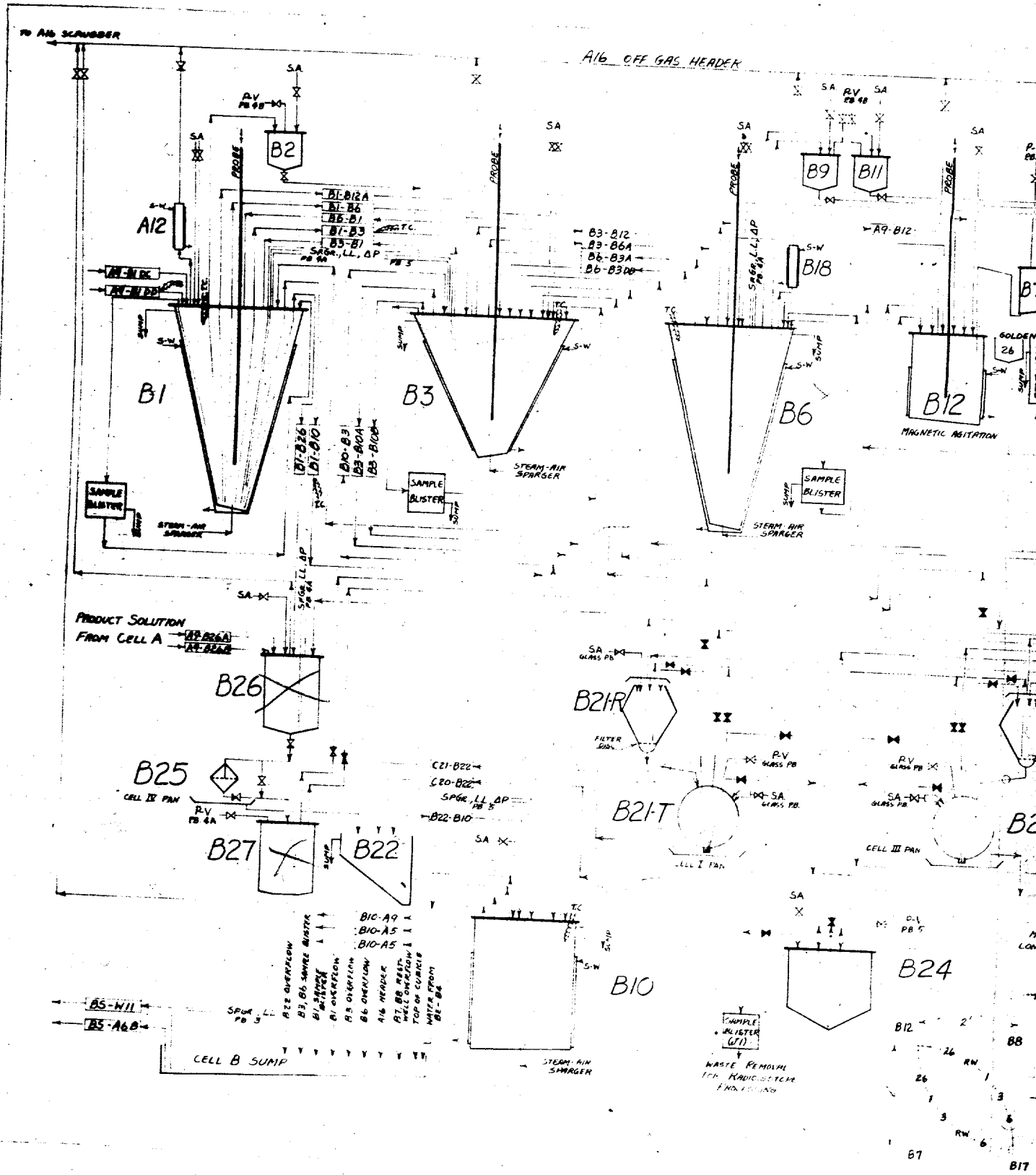
To the sulfate precipitate in A-9, 2500 ml of forty percent potassium carbonate is added. This solution is digested for fifteen minutes at 85-95°C. The lead and barium carbonate formed by this treatment is soluble in this concentration of potassium carbonate. While maintaining the temperature at 85-95°C, thirty-five pounds of water is added over a period of thirty minutes. The diluted solution is digested for thirty minutes at the reaction temperature. The solution is now cooled to approximately 30°C over a 30 minute period, to bring about good crystal growth. The agitation is turned off and the precipitate is allowed to settle for two and one-half hours. After this settling time, the supernatant liquor is decanted to A-8 which contains four liters of seventy percent nitric acid to dissolve any precipitate lost in decantation so that a representative sample of the waste may be taken.

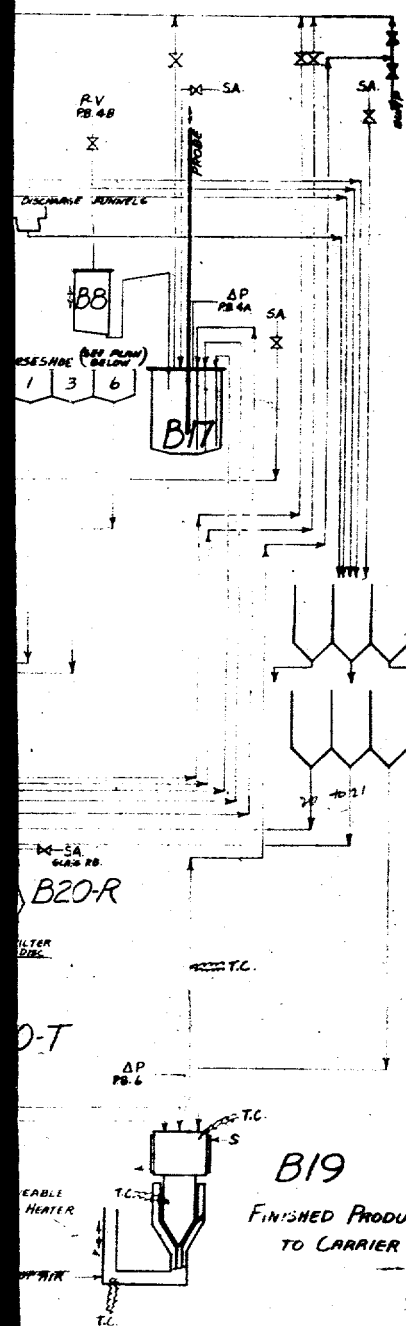
The above procedure is repeated. After the second metathesis, the waste liquors neutralized with nitric acid are sampled. The carbonate cake is next washed with two thirty-three pound portions of water with an intermittent settling for two and one-half hours and subsequent decantation to A-8. These water washes combined with the metathesis waste, are sampled to determine the losses.

Solution of Metathesis Cake

With the mechanical agitator turned on, 500 ml of seventy percent nitric acid is added through a funnel to A-9 and the contents agitated for 5 minutes. The nitric acid solution is now jetted to B-26 and blown to B-12 by way of the crud filter and B-27.

320 ml. more of seventy percent nitric acid is added to A-9 followed by a line rinse of 350 ml. of water. This portion of nitric follows the same path as the first addition. Water is next used to rinse addition and transfer lines and the vessels, A-9, B-26, crud filter, and B-27. The amount of this water wash is limited by the volume desired in B-12 which is 4 liters. When calculating the volume of rinse water to be used, the volume in B-12 before the rinse water added, and jetting dilution must be taken into consideration.





DESCRIPTION OF EQUIPMENT		
NUMBER	NAME	DESCRIPTION
A 12	CONDENSER	CONDENSER
B1	PRECIPITATOR	PRECIPITATOR
B2	FILTER PAPER	FILTER PAPER
B3	CANAL TANK	CANAL TANK
B6	PRECIPITATOR	PRECIPITATOR
B7	MIXING PAPER	MIXING PAPER
B8	MIXING PAPER	MIXING PAPER
B9	FILTER PAPER	FILTER PAPER
B10	MIXING TANK	MIXING TANK
B11	FILTER PAPER	FILTER PAPER
B12	ELECTROLYTIC CELL	ELECTROLYTIC CELL
B17	SAMPLE HOLE	SAMPLE HOLE
B18	CONDENSER	CONDENSER
B19	EVAPORATOR	EVAPORATOR
B20-R	GLASS REACTOR	GLASS REACTOR
B20-T	GLASS REACTOR	GLASS REACTOR
B21-R	GLASS REACTOR	GLASS REACTOR
B21-T	GLASS REACTOR	GLASS REACTOR
B22	CANAL TANK	CANAL TANK
B23	MIXING TANK	MIXING TANK
B24	MIXING TANK	MIXING TANK
B25	CANAL TANK	CANAL TANK
B26	REACTOR TANK	REACTOR TANK
B27	TRANSFER VESSEL	TRANSFER VESSEL

SA	SAFETY
RV	REACTOR VESSEL
FB	FILTER PAPER
LL	LIQUID LEVEL
S	SAMPLE
M	MIXING
AP	APPROXIMATE
T.C.	TEMPERATURE CONTROL
M	MIXING

EQUIPMENT	
CELL B	CELL B
NAME	NAME
CLIMATE	CLIMATE
NO.	NO.
DATE	DATE
TIME	TIME

CELL B EQUIPMENTB-26 Receiver

The receiver is used as a holdup tank in the transfer of the product solution from precipitator A9 to the crud filter in Cell IV. The closed receiver is a 25-12 stainless steel cylindrical tank with a shallow cone bottom and bottom outlet, and has a capacity of 5.5 liters. Agitation, heating and cooling are not provided for this tank. Vacuum is supplied by the A16 off-gas system. The receiver is mounted on the west wall at the south end of Cell B. Details of the tank and supports are shown in ED-379DA.

Other services in B26 include:Solution In:

Jet A9-B26A
Jet A9-B26B
From 3rd floor funnel
From B1 and B8 pipettes via golden horseshoe funnel
Jet B1-B26 (alternate route of transfer from A9 to B26 via B1 space precipitator).

Solution Out:

Through bottom outlet to B27 transfer vessel via B26 crud filter by vacuum on B27.

Instrumentation:

Liquid Level Manometer, PB4A-6
Specific Gravity Indicator, PB4A-7
Pressure Manometer, PB4A-9

B-27 Transfer Vessel

The transfer vessel is a pressure and vacuum tank for receiving the filtered solution from B-26 and transferring it to B-12 for electrolysis. The closed vessel is a 25-12 stainless steel cylindrical tank with a capacity of 5.5 liters. Details of tank and supports are shown in ED-379-DA and D-3. Agitation, heating and cooling are not provided for this tank. The tank is serviced by pressure and vacuum. Location of the tank is directly beneath B-26 on the west wall at the south end of Cell B.

Other services to B-27 include:Solution In:

From B-26 crud filter or B-26 via by-pass.

Solution Out:

Two lines to B-12 electrolytic cell by pressure on B-27.

Instrumentation:

Pressure-vacuum gauge at PB4A.

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Electrolytic Cell

The electrolytic cell is used for removing lead from the product solution. The closed vessel is a 25-l2 stainless steel jacketed, cylindrical tank with a slightly sloping bottom and a capacity of 5.8 liters. The jacket is serviced by steam and water and agitation is accomplished during electrolysis by four permanent magnets surrounding the tank. The tank contains a platinum liner to prevent the would be electrolytic action of the constituents of stainless steel from interfering with the electrolysis of the product solution. The electrolysis apparatus consists of a cylindrical platinum gauze, the cathode (-), with open ends through which is inserted a platinum rod, the anode (+). The platinum liner is also connected to the anode. The tank is vented to the A16 off-gas system and is mounted on the west wall of Cell B. Details of the tank are shown in CL-706D-154.

Other services to B-12 include:Solution In:

From 3rd floor funnel.

Two lines from B-27 transfer vessel by pressure on B-27.

Jet B1-B12A.

Jet B3-B12.

Jet A9-B12 (Alternate route of transfer from A9 to B-26 via B7 or B8 and golden horseshoe funnel, or in case crud filtration be omitted).

Solution Out:

To B7 or B8 movable pipette by vacuum on the pipettes.

Instrumentation:

Probe from 3rd floor for sampling and obtaining accurately the liquid level.

D.C. supply, voltmeter, resistor and ammeter on PB4B.

M.G. set for recharging batteries, 3rd floor.

B7 and B8 Movable Pipettes

The movable pipettes are used for taking up solutions from B12 and B17 and discharging the solutions into the golden horseshoe funnels or the upper discharge funnels. The pipettes are 18-8 stainless steel cylindrical vessels with sloping bottoms and two capillary tubes extending from the bottom of each vessel up the outside of the vessels to the level of the tops of the vessels, thus forming traps, and then down again for extending into the tanks and funnels. The capacity of each of the vessels is 8 liters and details are shown in CL-706D-206, 207, and 208. The pipettes are operated from the 3rd floor, the operation consisting of raising and lowering and rotating the vessels about their axes, thus swinging the capillary tubes on arcs, the radii of which are 24 inches. The arcs of swing of the pipettes overlap such that they intersect at one end directly over the B12 nozzle and at the other end over the B17 nozzle, the funnels and restwell of each pipette lying along the respective arcs. The above described assembly is known as the golden horseshoe rack. There is also an upper discharge funnel for each pipette located along the arc of swing but above the golden horseshoe rack.

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Services to B7 and B8 include:

Solution In: (Vacuum on pipettes)

From B12 and B17.

From Restwells.

Solution Out: (Pressure on pipettes)

To: B26, B1, B3, and B6 via golden horseshoe funnels.

To: B19, B20 and B21 via upper discharge funnels and
B23 movable funnel rack.

Instrumentation:

Pressure manometers,

PB4B-16 & 18;

Air flow indicator and amplifier for
contact microphone,

PB4B-20.

Golden Horseshoe and Upper Discharge Funnels

Although the purpose of the golden horseshoe and upper discharge funnels was explained in the preceding section, more pertinent data are necessary for a complete description of the equipment. The 18-3 stainless steel upper discharge funnels consist of a 4" diameter by 1 $\frac{1}{2}$ " high cylinder welded to the top of a 2" diameter by 3" high cylinder with a stainless steel screen fitted into the upper cylinder for catching foreign materials. The discharge lines from the two funnels are joined and a common line goes to the B23 movable funnel rack.

The 18-3 stainless steel golden horseshoe funnels consist of a 6" x 6" rectangular trough about 2" deep with the discharge lines from each pair of funnels joining and the common lines going to vessels B26, B1, B3 and B6. These funnels also contain stainless steel screens. The 18-3 stainless steel restwells for the pipettes are constructed of 2" IPS by about 15" long and each has a solution addition line from hole BW-C5 entering the bottom of the restwells.

B6 Precipitator and B18 Condenser

The precipitator serves only to reduce the volume of product solution after lead has been removed in B12 electrolytic cell. The vessel is a 25-12 stainless steel frustrum-of-cone tank with a sloping bottom and a capacity of 44 liters. The tank has an 18-3 stainless steel jacket serviced by steam and water, and a single line serviced by steam and air enters the bottom of the tank for agitation. A reflux condenser, B18, is connected to the top of the tank and to the A16 off-gas system. The condenser, which is a jacketed, stainless steel 3" IPS by 3'-6" long, is actually used as a heat exchanger for driving off vapors from B6 during volume reduction. However, both steam and water are connected to the jacket of the condenser. The precipitator overflows to Cell B sump. Details of tank are shown in CL-706D-110.

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Other services to B6 include:Solution In:

Two lines from 3rd floor funnels.
From B7 or B8 pipette via golden horseshoe funnel.
Jet B1-B6.
Jet B3-B6A.

Solution Out:

Jet B6-B3DB.
Jet B6-B3A.
Jet B6-B1.
To B9 fixed pipette by vacuum on B9.
To B11 fixed pipette by vacuum on B11.

Sampler:

Standard sampler at wall plug BE-C3.
Probe from 3rd floor.

Instrumentation:

Liquid level probe from 3rd floor.
Liquid level manometer, PB4A-12;
Specific gravity indicator, PB4A-10;
Pressure Manometer, PB4A-13;
Temperature recorder, PB4A-5;
Sparger Indicator, PB4A-11.

B1 Precipitator and A12 Condenser

B1 precipitator is identical in design and construction to B6 and is used as a spare for volume reduction in case of B6 failure. A12 condenser, identical to B18 condenser on B6, is connected to the top of B1 and to the A16 off-gas system. B1 precipitator is also used as an all-purpose tank, such as a holdup tank in the transfer of product solution from Cell A to Cell B (A9-B1 and B1-B26) in case the two jets from A9 to B26 fail, and as a storage tank for various solutions. Sparger and jacket services are the same as for B6. Details of tank are shown in CL-706D-110.

Other services to B1 include:Solution In:

Jet A9-B1DC.
Jet A9-B1DD.
Jet B6-B1.
Jet B3-B1.
From B7 or B8 via golden horseshoe funnel.
Two lines from 3rd floor funnel.

Solution Out:

Jet B1-B12A.
Jet B1-B6.
Jet B1-B3.
Jet B1-B26.
Jet B1-B10.

Sampler:

Standard sampler at wall plug BW-C3.
Probe from 3rd floor.

Instrumentation:

Liquid level probe from 3rd floor,
Liquid level manometer, PB4A-3;
Specific gravity indicator, PB4A-1;
Pressure manometer, PB4A-4;
Temperature recorder, PB4A-5;
Sparger indicator, PB4A-2.

B2, B9 and B11 Fixed Pipettes

B2 and B9 or B11 are vessels used for transferring product solution from B1 and B6, respectively, to the glassware via B23 movable funnel rack. The closed vessels are 18-8 stainless steel cylindrical tanks with cone bottoms and are identical in design and construction. Each pipette has a capacity of 2.7 liters and contains at the bottom outlet a foot valve which is operated from the 3rd floor. Vacuum and pressure is used for transferring the solutions through the pipettes. Details of the pipettes are shown in CL-706D-217 and 218.

Other services for each of the pipettes include:

Solution In:

From 3rd floor funnel.

Instrumentation:

Pressure-vacuum manometers, PB4B-15, 17 & 19;
Air flow indicator and contact
microphone amplifier, PB4B-20.

B23 Movable Funnel Racks

The movable funnel rack is used as a means of diverting the flow of product solution to either of three vessels, B21R glass reactor in Cell I, B20R glass reactor in Cell III, and B19 final evaporator. The assembly consists of two sets of three funnels each, the upper set being mounted on a rack such that it may be moved back and forth in an east-west horizontal plane by means of a rod extending through wall plug BW-C7, and the lower set being

stationary. By having all the inlet lines converge over the central funnel of the movable set when the set is in the neutral position, the incoming solution may be diverted to the appropriate stationary funnel below simply by moving the upper set to any one of the three positions, "in", "neutral", and "out". Each funnel is an open 25-12 stainless steel cylindrical vessel with a conical bottom, the cylinder being constructed of 4" IPS by 6" high. Each funnel contains a stainless steel screen. The outlet lines from the two outside funnels of the upper, movable set are offset in order that they may be in line with the corresponding funnel below when the upper rack is in the in or out position. The funnel rack is located near the north end of Cell B on the West wall, and details are shown in ED-337-DA. Solution lines include:

Solution In:

- From B2
- From B9
- From B11
- From upper discharge funnels
- From 3rd floor funnel

Solution Out:

- To B21R (rack in out position)
- To B20R (rack in neutral position)
- To B19 (rack in in position)

B21R, B21T, B20R and B20T

The glass equipment in the cubicles outside of Cell B is described in a separate section of this manual.

B17 Sampling Vessel

The final sample of the product solution is taken in vessel B17 before the transfer is made to B19 for final evaporation. The closed, cylindrical vessel is constructed of 5" IPS Hastelloy C and is about 9" high having a capacity of 2.8 liters. Details of the tank are shown in ED-382D. As has been previously mentioned, the tank is located at the end of the golden horseshoe rack opposite B12 electrolytic cell. Therefore, B7 and B8 pipettes may be used in transferring solutions to and from B17. The vessel is connected to the A16 off-gas system.

Other services to B17 include:

Solution In:

- From 3rd floor funnel.
- From B24 by pressure on B24.
- From B21T by pressure on B21T.
- From B20T by pressure on B20T.
- From B7 or B8 by pressure on B7 or B8.

Solution Out:

To B7 or B8 pipettes by vacuum on pipettes.
To B21T by vacuum on B21T.
To B20T by vacuum on B20T.
To B24 by vacuum on B24.

Sampler:

Probe from 3rd floor.

Instrumentation:

Liquid level probe from 3rd floor.
Pressure manometer, PB4A-14.

B3 Wastes Receiver

Catch tank B3 receives the fuming nitric acid wastes from the glassware and the lead oxide wastes from B12 electrolytic cell. The vessel is a 25-12 stainless steel frustum-of-cone tank with a sloping bottom and has a capacity of 58 liters. The tank has an 18-6 stainless steel jacket serviced by steam and water. Agitation is accomplished by a sparger line entering the bottom and serviced by steam and air. The tank is connected to the A16 off-gas system and contains an overflow line to Cell B sump. The tank is located near the door of Cell B above B10. Details of the tank are shown in TD-56.

Other services to B3 include:

Solution In:

From B12 via B7 or B8 pipettes and golden horseshoe funnels.
From B21T by pressure on B21T.
From B20T by pressure on B20T.
Jet B6-B3DB.
Jet B6-B3A.
Jet B10-B3.
Jet B1-B3.
Two lines from 3rd floor funnels.

Solution Out:

Jet B3-B10A.
Jet B3-B10B.
Jet B3-B1.
Jet B3-B12.
Jet B3-B3A.

Sampler:

Probe from 3rd floor.
Standard sampler at wall plug BE-C6.

Instrumentation:

Liquid level probe from 3rd floor,	
Liquid level manometer,	PB5-6;
Specific gravity indicator,	PB5-8;
Pressure manometer,	PB5-5;
Temperature recorder,	PB5-3;
Sparger Indicator,	PB5-7.

B10 Wastes Holdup Tank

B10 holdup tank is used for storage of all waste materials from Cell B prior to transfer to the tank farm via A5. The vessel is a 25-12 stainless steel cylindrical tank with a slightly sloping bottom and has a capacity of 100 liters. The tank has an 18-8 stainless steel jacket serviced by steam and water. Agitation is accomplished by a sparger line entering the bottom and serviced by steam and air. The tank is connected to the A16 off-gas system and contains an overflow line to Cell B sump. The tank is located just inside the door of Cell B at floor level. Details of the tank are shown in CL-706D-112. Other services include:

Solution In:

From 3rd floor funnel.
Jet B22-B10.
Jet B1-B10.
Jet B3-B10A.
Jet B3-B10B.

Solution Out:

Jet B10-B3.
Jet B10-A9.
Jet B10-A5A.
Jet B10-A5B.

Instrumentation:

Liquid level manometer,	PB5-1;
Specific gravity indicator,	PB5-2;
Pressure manometer,	PB5-4;
Temperature recorder,	PB5-3.

B24 Wastes Holdup Tank

Tank B24 is used in storing HCl-ether wastes from the glassware prior to removal for radioisotope processing. The closed vessel is constructed of Hastelloy C and is 6" x 6" x 8" deep with a trough bottom and has a capacity of 5 liters. A special sample collection blister is located outside hole BN-J1 for the removal of wastes from B24 for radioisotope processing. Pressure and vacuum are supplied to the tank. Details are shown in WD-361-DA. Other services include:

Solution In:

From 3rd Floor funnel.
From B21R and B21F glassware by vacuum on B24.
From B20R and B20T glassware.
From B17 by vacuum on B24.

Solution Out:

To B21R and B21F glassware by pressure on B24.
To B20R and B20T glassware by pressure on B24.
To B17 by pressure on B24.
To blister outside hole BM-31 by pressure on B24.

Instrumentation:

Pressure-vacuum gauge, PB5.

Cell B Sump

The sump collects all spills and overflows from Cell B equipment and piping and is located along the full length of the west wall of Cell B. The sump is about 12" x 12" and is lead lined, sloping toward the south end. Services for the sump include:

Solution In:

Overflow from B1.
Overflow from B3.
Overflow from B6.
Overflow from movable pipettes restwells.
Overflow from B22.
Addition line from top of Cell II cubicle.
Drain lines from sample blisters B1, B3 and B6.
Drain line from A16 off-gas manifold.

Solution Out:

Jet BS-III.
Jet BS-ASB.

Instrumentation:

Liquid level manometer, PB3-1;
Specific gravity indicator, PB3-2.

CELL B - FINAL PRODUCT EQUIPMENT

The northeast corner of Cell B is occupied by the chimney (See CL-706D-253) which is approximately 20 feet deep. Its purpose is to provide radiation shielding when the final product assembly is introduced into or removed from Cell B. The north and east walls of the cell form 2 sides of the chimney. The south and west sides of the chimney, facing the interior of the cell, are made of concrete 10 inches thick and hang down to within $5\frac{1}{2}$ feet of the floor. The top, which becomes part of the Cell B roof, consists of five removable concrete blocks of decreasing size, the smallest of which is 3 feet square and which fixes the effective cross section of the chimney. The two bottom blocks are in one piece. During Cell B operations, the top of the chimney is closed to allow maintenance of vacuum and for general safety.

Carrier Guide Pipes

Carrier guide pipes (CL-706D-256) are placed vertically in the chimney to maintain alignment of the carrier as it is raised or lowered. The guide on the east wall is made of two parallel steel pipes so spaced that the guide pin on the carrier will slide loosely between them. It extends from just below the lowest concrete slab to about one foot above the dolly track. At the upper end the pipes are flared away from each other about 12 inches to simplify threading the guide pin. The arrangement on the west wall of the chimney is somewhat different. The pipes do not extend down as far since they must be short enough to be cleared by the carrier when it is moved toward the B-19 area. To overcome this, the dolly has two vertical pipes so placed that when it is in position to receive the carrier they are directly in line with the other pipes but about one foot short of connecting with them. During the actual elevating or lowering of the carrier, this guide is made continuous by lowering two long rods through the pipes on the wall and the dolly. These rods rest in the wall pipes when they are not being used and may be fixed in the upper position or lowered into the dolly pipes at will.

Dolly Tracks

At the bottom of the cell in line with the chimney, two stainless steel rods (CL-706D-246) lying parallel to the north wall act as tracks for the carrier dolly. They do not lie directly on the floor but are supported by a concrete and metal structure, the details of which can be seen on the print.

Dolly

The dolly (CL-706D-245 & 246) is a stainless steel four wheeled cart resting on the tracks at all times. Its purpose is to move the product carrier from its initial position beneath the chimney to any desired point in the B19 area and back. Distance of travel is limited to $5\frac{1}{2}$ feet. The dolly has four projections coinciding with four holes on the bottom of the carrier for alignment.

Dolly Control

The dolly is moved by a control (GL-706D-262) which consists essentially of a rod fastened to the dolly and a hand lever outside the cell which actuates the rod. This apparatus is located on the first floor at the north end of the west wall.

Product Carrier

The carrier (GL-706D-243 & 244) is a cylindrical steel shell, lead filled except for the center hole in the top for holding the cone and cone collar. It weighs about 3000 pounds. It was designed to give a minimum of about 10 inches of lead shielding around the product while handling outside the cell and in shipment. The top of the carrier has two holes into which two pins on the bottom of the adapter fit to align the adapter. The bottom of the carrier has four holes which fit the projections on the dolly to align the carrier in the cell. The two "ears" used for hoisting the carrier are fitted with removable guide pins which keep the assembly in line during vertical motion in the chimney. A steel hood covers the opening in the top and a gasket insures a water tight seal. A coil compression spring in the hood bears against the plug to hold it and the cone in place during transit.

Yoke

The yoke (GL-706D-251) is used for lifting and moving the carrier with the hoist. It is a steel beam crosspiece fitted with a ring for the hoist hook. At both ends are heavy steel rods going downward and ending in hooks, bent in opposite directions, which fit the "ears" of the carrier.

Cone and Cone Collar

The cone (ED-295 & 1272-3A) holds the product solution during final evaporation and the dried product remains in the cone during shipment. Cones for "Y" shipments are tantalum lined. The cone is cylindrical with the bottom being closed and conical. The open top has a shoulder which joins it with three screws to the cone collar (ED-295). The collar is a larger cylindrical piece also having a shoulder on top. This shoulder has three rings 120° apart through which slide the adapter bars. The cone and collar assembly fit loosely in the carrier.

Cone Plug

The cone plug (GL-706D-244) is a stainless cylindrical shell filled with lead to act as a radiation barrier when the product is in the carrier. It also aids in holding the cone and collar securely in place. The lower section extends part way into the cone. "Y" cones have this lower section covered with platinum. The upper part occupies the space inside the collar.

This provides about ten inches of lead shielding above the product which is roughly equivalent to that existing on the sides and bottom. A Koroseal gasket fits around the smaller cylinder and is cemented to the bottom of the larger one. A lifting ring in the top of the plug allows easy insertion or removal.

Plug Lift

The plug lift (CL-706D-250) is a grout filled pipe extending from the floor of the third level down into the cell through a hole in the cell roof. The bottom end has a hook and the top a handle for lifting manually or by a hoist. A pin secures the lift in the top position.

Cone Adapter

The cone adapter (CL-706D-247) is a device for remote control handling of the cone and cone collar. It is attached to the collar and cone assembly outside the cell and is not removed until the carrier is finally taken from the cell. (It is an 18-3 S Ch rectangle approximately 8 x 11 inches with a 6-17/32" hole in its center). Near the periphery of the circular hole, 120° apart, are rod holders fitted with set screws to hold the rods in place. The holes in these chucks are so directed that the rods point toward the center of the hole. The cone and collar fit inside the hole and the rods slip through the rings of the cone collar to hold it and the cone in place. Each rod has a threaded hole at one end into which a smaller rod may be screwed. This permits moving the rods in or out from a distance so the operator will not expose himself unnecessarily. On top of the adapter, running along the short sides, are two built up channels or slots. Their purpose is to receive the two arms of the elevator. To insure the correct position, each channel has a 7/16" hole in the top and center into which a pin on the elevator arm fits. The bottom of the adapter has two pins that fit into holes in the top of the product carrier. They also serve to orient the equipment.

Cone Elevator

The elevator (CL-706D-247) is a vertically movable bracket having two horizontal arms or extensions which engage the cone adapter. It is fastened to the west wall in line with the center of the dolly. It is raised and lowered by a control pipe, filled with grout, extending through the ceiling to the floor of the third level. A chain hoist is used to give better control of movement. Its purpose is to raise the cone and cone collar from the carrier into position below the head heater.

Cone Heater

There are two heating systems used to evaporate the product solution. The first to be described involves the cone heater (CL-706D-247 & 248). It is somewhat funnel-like in shape and open at the top with the bottom part leading

into a $1\frac{1}{2}$ " pipe through which hot air enters. The upper part is double walled with powdered MgO filling for insulation. It was designed to envelop the cone loosely to allow free passage of the air. At the top, around the periphery are four pipes, $\frac{1}{2}$ " long, welded vertically. They bear against the bottom of the cone collar when the heater is in position, thus providing space for air flow. To insure proper centering of the heater around the cone, four half round spacers are welded on the inside wall of the heater. The $1\frac{1}{2}$ " hot air inlet pipe extends downward from the heater several inches and makes a right angle at which point a thermocouple well is inserted. This thermocouple indicates heater air temperature. The pipe then runs horizontally about 14" and swings upward. In this vertical section, connection is made to a flexible hose which in turn is connected to either of two electric air heaters located outside the cell. Above this connection the vertical pipe is secured by a flange to the heater control, a device which swings and raised or lowers the heater. Vertical movement is limited to about 12". This control is simply a pipe filled with grout as a radiation shield extending through the ceiling to the third floor where a handle is attached. It is raised or lowered by a hoist located on the third floor and is swung manually. When not in use, the heater rests in its lower position near the west wall. To put into operating position it is swung counter-clockwise (looking down) until it lies below the cone and then raised until the four pipes previously mentioned touch the bottom of the cone collar. This operation is done with the aid of several periscopes to be described later.

There are two electric air heaters (GL-706D-257) located on the north wall of Cell B, their purpose being to provide hot air to the cone heater. Only one is used at a time, the other being a standby. To change from one to another it is necessary to loosen the flanges in the exit lines and transfer the orifice blank. Each heater is made of 20 gage sheet steel welded into the form of a tunnel with a cross-section of 5 x 11 inches and roughly $2\frac{1}{2}$ feet long. The ends taper to fit 2-3/8" pipes for inlet and exit air. A metal jacket containing 85% Magnesia blocks $2\frac{1}{2}$ " thick surrounds the rectangular section and also the tapered section on the exit side. The top part of this jacket forms a removable cover to facilitate wiring, maintenance, and repair. The bottom is also removable for replacement of elements. Sixteen 2 KW Calrod hairpin heaters operating on 230 V, hang in the tunnel and are in direct contact with the moving air. A series of fins aids in obtaining greater heat transmission. An adjustable thermostat can be set to cut off the current when a certain outlet air temperature is reached. This is a safety precaution and not an operating convenience since the current will not be turned on automatically when the temperature drops. It must be reset at Panel Board 6. Each heater has three thermocouples to indicate temperatures at various points. The exit air pipes from the two heaters are manifolded into one line which enters the cell wall and connects to the flexible hose inside the cell. A thermocouple at the junction gives outlet air temperatures.

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Head Heater

The other heating system, utilizing 25 pound steam, is the head heater (CL-706D-249 & ED-362). It contributes very slightly to raising solution temperature in the cone. Its main purpose is to super heat the vapors from the solution to prevent condensation on the bottom part of the head heater. Air enters around the top of the cone collar and goes out the off-gas line. This removes saturated air and thus increases the driving force. The heater is essentially a cylinder 6" high and 4" O.D. closed at both ends with a number of pipes entering it at the top. It is bracketed in a vertical position by a support plate to the north wall of the cell about 4' above the floor and 2' from the west wall. The piping arrangement, which is somewhat complicated, is best understood by inspection of the equipment and drawings. Five pipes of varying diameters are visible emerging from the top of the cylinder. They go through holes in the support plate to which they are welded, thus holding the assembly rigidly in place. The largest pipe has two smaller ones running through it concentrically but only one annular space is used. Another pipe has one smaller one running through it with no annular space. Thus, with a total of 8 pipes only 6 are available for fluid flow and temperature measurement. Only three of the lines emerge from the bottom of the heater. One, extending 1-3/8" and closed at the end, is a well for a thermocouple indicating temperature above the solution. This pipe is centered in a larger one serving as the off-gas line. However, the off-gas line does not extend below the bottom surface of the heater. The third pipe is the solution addition line and it extends 1 1/2". Above the support plate it is manifolded into three lines leading from B-20, B-21, and B-23. Line four holds a thermocouple for off-gas temperature and the other two are for steam inlet and outlet. The steam inlet opens to the interior of the heater, thus raising the temperature of the entire assembly. All lines in contact with solution or fumes are made of Hastelloy C. The heater is so located that when the carrier is moved under it and the cone lifted with the elevator it is centered inside the cone collar. This is the operating position.

Viewing Cone

Complete dryness of the product is determined by inspection with a periscope in wall plug BH-J2. A viewing cone is held opposite this hole by a bracket so that when the carrier and cone are directly below it the product can be seen. The purpose of the cone is to limit the field to the cone area and to cut off extraneous light which would otherwise make the inspection difficult and uncertain.

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Panel Board #8

Panel Board 6 is used for control of product solution evaporation. It is located on the north side of the second level. A Micromax records the following temperatures: head heater, above solution, cone heater, and off-gas. Another instrument fitted with a selector switch gives temperatures of different points in the electric heaters including two in Number One and three in Number Two and the exit air from either of these heaters. Also on this board are the switches and Variacs for operating the heaters and the valves and manometer for air flow control. Head heater instruments include the B-19 cell and off-gas manometers and bubblers, the head heater steam valve with a blow-down valve, and a steam pressure gage. The B-19 off-gas valve (B19-A16) is located on the floor of the third level in the sampler probe area. This off-gas line has a drain valve on the first level near the dolly mover.

Periscopes

Since many of the B-19 operations involve movement of equipment inside the cell it is important to be able to see them. Two types of periscopes are provided. One is electrically operated and flipping a switch results in a change of field. The other kind is located manually. Either style may be moved in or out by hand to select the desired objective. There is a number of holes in the cell wall on the first and second levels, north and west sides to accomodate either type of scope. By proper placement of at least four instruments it is possible to witness all critical B-19 operations.

CELL B PROCESSSummary of the Process

The metathesis cake in A9 is dissolved in 70% HNO_3 and the solution transferred to B26 in preparation for filtering. Vacuum is applied to B27 transfer vessel and the solution is filtered through B25 crud filter to B27 in order to remove the undesirable insolubles from the solution before proceeding with the final purification steps. The filtered product solution is then transferred to the B12 electrolytic cell where the contaminating Pb is removed as PbO_2 . The volume of the product solution is reduced in the B6 precipitator and transferred to the glass reactor in the lead cubicle outside of Cell B. Subsequent treatments with fuming HNO_3 , HCl -ether, HCl -alcohol and absolute ether remove the contaminants, Lanthanum, Iron, Nickel, Chromium, Lead and Strontium, the Barium Chloride precipitate remaining in the reactor. The final product, Barium Chloride, is dissolved in water and transferred to B17 from which the final sample is taken. The solution is then transferred to B19 where it is evaporated to dryness prior to shipping.

Cell B Operation

The initial step in Cell B is the crud filtration of the product solution. The three valves at B26 and B27 which are located in the lead cubicle outside of Cell B are closed, and vacuum on B26 receiver is adjusted to 5" water with the B26-A16 off-gas valve on the third floor. Transfer of the nitrate solution (metathesis cake in 500 cc 70% HNO_3) from Cell A to Cell B is started with jet A9-B26B while one operator remains at the B26-A16 vacuum control valve in order to maintain a negative pressure on B26 during the jetting operation. The fact that B26 receiver has a capacity of only 6.5 liters necessitates the careful pressure control on this vessel to prevent blowing fluid out of the manometer and possibly contaminating the panel board.

When the jetting to B26 is complete, the volume, usually 2500-3000 cc, is calculated from the liquid level and specific gravity readings.

The filtration is started by first applying vacuum to B27 and then opening the valve between B25 and B27 followed by opening the valve between B26 and B25. The application of vacuum to B27 and the opening of the valves must be carried out in the order mentioned to prevent loss of solution around B25 in case the ball joint connections at B25 are loose.

When filtration is complete, as noted by a decrease in the vacuum, the vacuum is shut off, all valves between B26, B25 and B27 are closed, and a pressure of 6 psi on the gauge is applied to B27 and the solution is transferred to the B12 electrolytic cell. The volume in B12 is probed and is usually found to be slightly less than that in B26.

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The entire procedure described above is repeated at least twice with rinses from A9 through the crud filtration step to the B12 electrolytic cell. The first rinse is made with 320 cc 70% nitric plus 500 cc water and the volume in B12 is again probed and usually found to be 3000-3500 cc. The second rinse is made with 500 cc water which increases the volume in B12 to 3500-4000 cc. The desired final volume in B12 is 4000 cc; hence, the proper amount of water is added to A9 for only additional rinses such that the final volume in B12 will be 4000 cc, allowing for the dilution which takes place during jetting from A9 to B26. Based on previous experience, an increase of 200 cc in the volume due to jetting at this point has been found to be a safe figure. For example, if, after the 500 cc water rinse, the volume in B12 should be 3700 cc, then 100 cc of water would be added to A9 in order to bring the total volume in B12 to 4000 cc. As an alternative, the final volume in B12 may be adjusted by adding the required amount of water to B26 or directly to B12; however, this procedure is acceptable only in emergencies.

After the final volume in B12 has been adjusted, the second step, lead removal, is ready to be carried out. Water is turned on the jacket of B12 and the direct current control bank switches on PB 4B are turned on such that the ammeter indicates 15 amperes. Electrolysis is allowed to proceed for three hours at that amperage. After three hours, the current is increased to 25 amperes by adjusting the control bank switches, and electrolysis is allowed to proceed for an additional seven hours. During the electrolysis, B6 may be made ready for receiving the solution from B12, and preparation may be made for sampling the solution in B6 (Sample Code #6F).

When electrolysis is complete, the solution is ready to be transferred from B12 to B6 with pipette B8, the current on the electrolytic cell remaining on during the transfer. The B8 movable pipette, which is operated from the third floor, is raised from the restwell position to the lower swing level by cranking the handle of the worm gear mechanism in a counter-clockwise direction. The locking pin on the swing plate is then pulled, the pipette rotated to the B12 position by turning the plate, and the locking pin put back in place. The pipette is then lowered to the position marked B12 and is ready for the solution to be drawn up into it by cranking the handle in a clockwise direction. 35" of vacuum, as indicated by the B8 manometer on PB 4B, is applied to the pipettes. The vacuum on the pipette will also drop as indicated by the pressure manometer. Without shutting off the vacuum, the pipette is raised to the lower swing level, the locking pin pulled and the pipette rotated to the B6 position and locked. The pipette is lowered to the lower discharge level, the vacuum shut off and 25" pressure on the manometer applied to the pipette. The solution is thus discharged into the golden horseshoe funnel which, in turn, discharges into B6 precipitator. Completion of the transfer is again indicated by the sound

from the amplifier and the drop in pressure. Pressure on the pipette is shut off and the pipette returned to the restwell position by way of the lower swing level. B12 level is probed to assure that no solution remains in it. The current and cooling water on B12 is shut off. The volume in B6 is calculated from the liquid level and specific gravity readings and the loss in volume due to lead removal and evaporation, is usually found to be in the order of 200-300 cc.

The third step, volume reduction, in Cell B operation is ready to be carried out after the #6P sample has been taken. The B6 air sparger is turned on and preparations are made for sampling the product solution. The sample blister jet is turned on and the sample tube put in place. After the solution has circulated for 15 minutes, the sample tube containing the #6P sample is removed and the jet turned off. Steam is turned on the jacket of B6 and B18 condenser and the air sparger is adjusted to 1" on the indicator instrument on PB 4A. As the solution in B6 is heating, the high pressure steam header on PE 4A is shut off and the by-pass opened in order to eliminate the chance of jets leaking into B6. The B9 and B11 foot valves and the solution addition valves to these pipettes, all of which are operated from the third floor, are closed, and slight pressure is applied to B9 and B11 to prevent plugging of the suction lines from B6 to each of the pipettes. For the same reason, the air flow to all B6 bubblers is turned up to a fast rate, and, as an added precaution, both manometers are equalized. The manometer equalizing valves are closed only when readings are to be taken and then, very carefully, so that no fluid is lost if a tube is plugged. Heating of B6 contents is continued until the solution is evaporated to dryness, which is approximately 30 minutes after the liquid level manometer reads zero. Two liters of distilled water are added to B6 through the splash plate addition line from the third floor. Heating is continued until the solution is evaporated down to 350 cc or 0.4" on the manometer, and steam is shut off B6 and B18 jackets. Water is turned on the jacket of B6 and the contents cooled to 40°C. The jacket water is shut off and the level in B6 read after all sources of agitation are turned off, such as bubblers, sparger and pressure on B9 and B11 pipettes. The product solution is now ready to be transferred to the glassware in the cubicles outside of Cell B by means of the B11 fixed pipette and the B23 movable funnel rack.

Air pressure of 3# on the gauge at the glass panelboard is applied to the B21-T transfer vessel, and the B23 funnel rack is moved in position for transfer to B21-R reactor by pulling the control rod underneath the glass panelboard all the way out. B9 and B11 foot valves and the solution addition valves are closed and the amplifier turned on. 30-90" of vacuum on the manometer is applied to B11 and the solution is drawn into it from B6. Completion of the transfer to B11 is noted by a drop in the vacuum and a gurgling sound from the amplifier. Vacuum is shut off and the B11 foot valve is opened. After the contents of B11 have drained into the movable funnel, which may be seen through a

specific receiver located in hole B1-B1, slight air pressure is applied to B11 pipette in order to blow forward any solution that might be trapped in the line. The transfer of solution may also be observed by viewing B21-R through a periscope located on the north side of Cell I cubicle. The air pressure on B11 and the B11 foot valve are shut off and the volume in B21-R read. The B6 bubblers are turned on and the air sparger is turned on to 1" on the indicator, preparatory to following up the transfer with two water rinses. 75 cc of distilled water is added to B6 through the splash plate addition line from the 3rd floor and is allowed to agitate for five minutes. The rinse solution is then transferred to B21-R as described above by way of B11 and B23. The second rinse consists of 75 cc of distilled water added as above and agitated for five minutes. The B6 bubblers and air sparger are turned off before transferring from B6 to B21-R as before. After the line from B11 to the funnel is air-blown and the B11 foot valve shut off as previously described, the final volume in B21-R is read and is found to be about 500 cc.

The operation of the glassware and final evaporation is described in another section of this manual.

Handling of Wastes

Fuming nitric acid precipitation wastes are transferred from B20-T to B3, the latter of which contains 20 liters of water which is added through the 3rd floor funnel prior to the wastes transfer (for complete description of transfer, see section on glassware operation). The B3 air sparger is turned on and preparations made for sampling the solution. The B3 sample blister jet (wall plug BE-06) is turned on and the sample tube put in place. After the solution has circulated for 15 minutes, the sample tube containing the #377N sample is removed and the jet turned off. The B3 air sparger is shut off and the volume read. The waste solution in B3 is then transferred to waste holding tank B10 with jet B3-B10A. B3 sparger is turned on and B3 is then rinsed with 2 or 3 liters of water added through 3rd floor splash plate funnel, and the rinse is transferred to B10 with jet B3-B10A. The B3 sparger is shut off.

The lead oxide wastes in B12 electrolytic cell are dissolved and transferred to B3 catch tank where the solution is sampled before being discarded. Four liters of 25% nitric acid and 100 cc of 30% hydrogen peroxide are added to B12 through the 3rd floor funnel. Ten minutes after the above addition, another 100 cc of 30% hydrogen peroxide followed with 200 cc of rinse water are added to B12. The contents are allowed to digest for 30 minutes after the last addition, during which time B3 is made ready for receiving the solution from B12. The B3 air sparger is turned on to 0.5" on the indicator and preparations are made for sampling the solution after it is transferred to B3. Forty minutes after the initial addition of the acid and peroxide, or thirty minutes after the final addition of peroxide and rinse water, the waste solution in B12 is transferred to B3

with movable pipette B7 by way of the golden horseshoe funnel. Operation of the movable pipettes has been described previously. After the transfer is completed, a second dissolving in B12 is made exactly as described above, and the solution, after digesting the usual forty minutes, transferred to B3. After the second transfer is completed, a final rinse of 4.5 liters of 25% nitric acid is added to B12 and immediately transferred to B3 with pipette B7. The B3 sample blister jet is turned on and the sample tube put in place. After the solution has circulated for 15 minutes, the sample tube containing the UWFb sample is removed and the jet turned off. The B3 air sparger is turned off and the volume read.

When analysis of the sample is obtained, the solution is transferred from B3 to B10 with jet B3-B10A. When B3 is empty as indicated by the nanometer and without turning off the jet, 4 liters of nitric acid are added to B3 through the 3rd floor splash plate funnel. When B3 is empty, the B3-B10A jet is turned off.

The waste solution in B10, which consists of the lead oxide waste as well as the fuming nitric acid waste that was added earlier to this tank, is transferred to A5 with jet B10-A5A or B, neutralized with NaOH , and then sent to W11 with jet A5-W11. Several liters of rinse water are added to B10 through the 3rd floor funnel and transferred to W11 as described above.

~~SECRET~~CELL B PROCESS - FINAL PRODUCT HANDLINGFinal Product Handling

Prior to the B17-B19 product solution transfer, certain preparations must be made. The product carrier to be used for shipment is moved from storage (above "hot" labs.) to the third level. A clean tantalum lined cone and cone collar, the adapter, and plug are obtained. The two guide pins are screwed into the "ears" of the carrier. The cone is placed in the carrier and the adapter is put over it, taking care to orient the adapter so that one chuck will face the B19 area (west). This allows clearance for the plug which later will hang in the cell while the carrier moves under it. If a short 708-C type plug is used, this precaution is not necessary. The two pins on the bottom of the adapter must fit the holes on the top of the carrier. Next, the cone and collar are rotated so that the three short rods of the adapter can be pushed through them--far enough to hold securely but not enough to prevent entry of the plug. It is important that these rods have their tapped ends facing outward because of the special removal technique required when the product is in the carrier. The set screws are turned slightly more than "finger-tight" with a small wrench to facilitate rapid loosening and so lessen personnel exposure. The Koroseal plug gasket is checked and the plug is then inserted into the assembly with the lift ring facing east and west. While this is being done, the other operators can make the other preparations.

The concrete blocks are removed from the chimney with the hoist and placed on the floor on top of one another just north of the chimney. Each block is provided with 3 rings to which are hooked three steel cables connecting to the hoist hook. This is a delicate operation and care must be taken to maintain equal tension in all three cables so that the blocks are lifted without tilting. Recesses are built into the bottoms of the last three blocks removed so that when they are properly lined up the lifting rings of each preceding block will fit into them. It is advisable to have an HP survey when opening the chimney. Four movable pipes fitted with chains are placed at each corner of the chimney to prevent personnel from falling into the cell. These should be in place at all times when the blocks are removed.

The dolly is now located at the east wall of the cell directly in the path of the carrier to be lowered. The guiderods are lifted with a long hook, rotated to release the catches, and dropped into position inside the pipes on the dolly. This forms a continuous guide on the west side. The east guide is immobile and permanent. The next step is to lower the carrier assembly down the chimney onto the dolly. This is done cautiously, making certain that the guide pins engage the guide rods properly and that the carrier bumps nothing in its descent. The four holes in the bottom of the carrier usually align themselves with the projections on the dolly but if they fail to do so, this can be accomplished with little difficulty by raising and turning the carrier slightly.

~~SECRET~~

The two west guide rods are now raised, rotated, and locked in the upper position. This gets them out of the path of the dolly and carrier. The double thickness block is put back into the chimney as a protection against radiation and falls. It also seals the cell to allow maintenance of vacuum.

From now on all operations must be done by remote control. It is very important that as many of these as possible are observed with the scopes. The next step is to make sure the plug lift is in its lower position. The dolly is moved westward until the plug lift hook engages the ring on the plug. When this is definitely established visually, the lift is raised to its upper position and locked with a pin. There is a portable mechanical lifter available but most operators prefer to do the job manually. The air heater must be out of the path of the elevator (rotated clockwise) and the elevator should be all the way down. The dolly is moved west (observe with scopes) until the elevator arms slide into the channels of the adapter and the centering pins are in line with the guide holes. The pins and holes should merge when the elevator is raised. The elevator is lifted until the adapter, cone, and collar are in place under the head heater and then locked. The operator can feel this since actual contact is made. At least four men are needed for these moving operations since several scopes are used and one man must operate the lifts. The carrier is now returned to its initial position under the chimney. Next, the cone heater is rotated counter-clockwise about 90° until it stops. It is then raised with the hoist while observing until the four vertical pins of the heater touch the under side of the shoulder of the cone collar. These pins maintain clearance for hot exit air. The chain hoist used is manually operated and holds the heater in place during subsequent operations.

At this point, the product solution which is in B17, is introduced into the cone. The B19-A16 off-gas valve is closed. Its path is as follows: B8 pipetto, upper discharge funnel, movable funnel rack (B23), and then into the cone (B19). The volume in B17 is usually about 200 ml. In this case, the transfer is followed by a water wash sufficient to make a total of 250 ml in the cone. The water is added to B17 via B20 or B21 and it then follows the same course as the product solution. In the event that the volume in B17 is nearer 150 ml, two water washes can be used without exceeding the 250 ml in the cone. If the B17 volume should be too great to allow a water wash and still keep within limits, it may be necessary to make two evaporations. After the first volume reduction, followed by a cooling period, the remainder of the solution could be transferred and this followed by one or two water washes. Much of this procedure is left to the discretion of supervision and is therefore difficult to describe exactly.

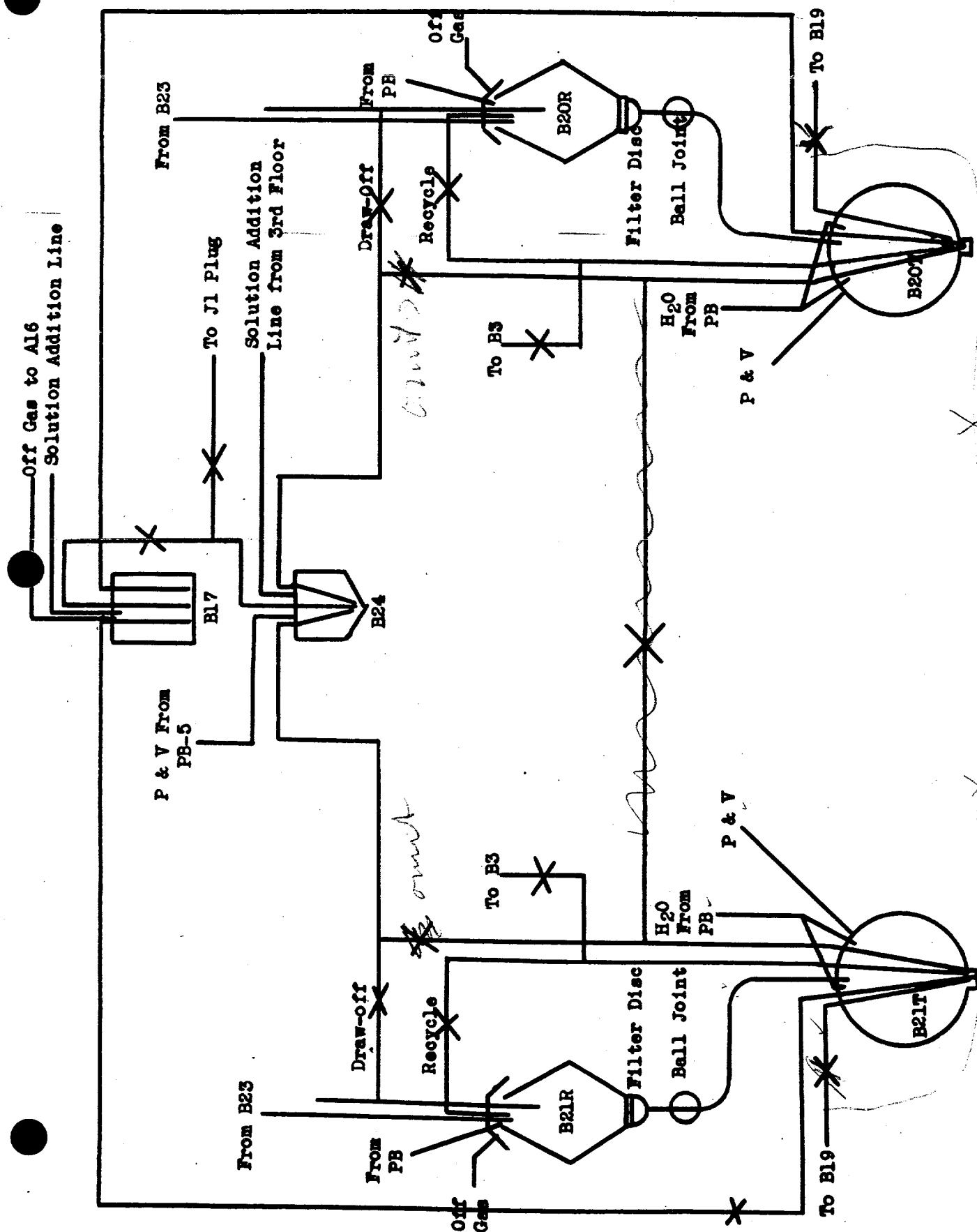
Most of the controls for evaporation are at Panel Board 6. The B19-A16 off-gas valve (3rd floor) is opened enough to maintain a flow of 0.3 inch on the panel board manometer. This manometer blows very easily so the equalizer valve is opened whenever flow rate adjustments are being made. One man operates the B19-A16 valve and another the equalizer.

Three to six pounds of steam to the head heater are turned on. 110°C is the desired temperature. Air to the cone heater is always turned on before starting the electric heater and it is left on during cooling. At first, it is customary to run air through at 10-20 inches on the manometer to reach the evaporating temperature more quickly. However, when this temperature is approached, air flow is adjusted to 25 inches (equivalent to 65 C.F.M.). A switch behind the panel board is used for selecting either electric heater for operation. The master starter is then turned on as are switches to both Variacs. At first, the Variacs are set at about 50, but they are later changed, if necessary, to maintain the desired cone heater air temperature of 145°C . If a certain outlet air temperature is exceeded, the heater will be cut off automatically and red lights on the panel board will go out. The heater must be restarted manually after sufficient cooling for the thermostat to reset itself. The thermostat regulates the outlet air temperature but the cone temperature is the most important one, so the thermostat was set to cut out when the cone temperature exceeded about 155°C when air flow was 65 C.F.M. However, it must be kept in mind that this is an indirect control and will not be very exact, especially if rate of air flow changes or other variables occur. Temperature control is best accomplished by regulating the Variacs. When evaporation temperature is attained, all temperatures obtainable off the Micromax and the variable indicator are recorded on the run sheet every 15 minutes. Cone temperature is kept at 145°C for four hours after which the product is inspected through a scope to see if it is dry. The steam and electric heater are turned off. The air is left on until the cone has cooled to $70-80^{\circ}\text{C}$. The cone heater is then lowered and rotated clockwise. The dolly is moved west until it is directly below the cone. A mark on the dolly mover rod helps spot the carrier but observation through scopes is necessary. The elevator is lowered all the way. This disengages the pins on the elevator arms from the adapter channel holes and frees the assembly. The carrier is moved until the cone is directly opposite hole B1-J2 and underneath the viewing cone. In this position it is possible to determine the condition of the product. If the product is not dry it must be returned for further evaporation.

Upon completion of drying, the product is ready for the ~~test~~ test to be started 16 hours after the last separation time (LST). The carrier is moved beneath the plug which is then lowered only part way into the collar and cone leaving the plug still suspended from the lift hook. The concrete block is lifted out of the chimney while a Health-Physics man makes his surveys. The chimney is covered by a heavy steel plate. All necessary instruments used in the test are assembled and made ready for use. An experienced man from the Analytical Group, assisted by Health-Physics, is in charge. An instruments man is present to keep instruments in working order. It is the responsibility of Operations to handle the carrier, concrete slab, metal plate, and to help wherever needed. When the readings are taken, the carrier is moved back under the plug which is again partly inserted. Twenty-six hours after LST, more readings are taken and the analysis is finished. The instruments and steel plate are removed and the carrier is ready for removal from the cell.

The plug is lowered all the way into the carrier. From here the dolly is moved under the chimney. The guide rods are put into place and the carrier is elevated and set on paper previously put on the floor. The following operations must be done quickly and carefully, in presence of HP, to avoid overexposure. The adapter-chuck set screws are loosened with a wrench and the rods are pulled back with the threaded rod pullers. The adapter can now be lifted off and the two guide pins are removed. Next the gasket and carrier hood are put in place and screwed down firmly. The carrier is moved to the first level. At this time, it is customary for HP to make its routine pre-shipment survey. If the outside of the carrier is contaminated it can be cleaned off in Room 9. The assembly is then ready for shipment and it is placed on the truck.

The product analysis is again checked at "Site-Y" where a direct radiation method is utilized. Readings are taken at 20 feet from the exposed product with an ionization chamber. In this chamber the current required to just balance the discharge is measured. The setup was standardized with a two gram radium source. Scattering with their technique averages about 10% while ours is nearer 100%. That fact, in addition to their greater experience, makes their method currently superior to ours.



Equipment Flowsheet B20, B21, B24, and B17
 (All Valves shown are in Cell II)
 Drawing No. P-9

CUBICLES - GENERAL INFORMATION

After several runs it became apparent that the glass equipment and the hastelloy valves were going to require constant maintenance and replacement. To make this more readily feasible, individual cells of lead were constructed so as to make this equipment accessible without the necessity of decontaminating Cell B.

Location and Description

The lead cells were constructed on the first level against the west wall of Cell B, the concrete wall of Cell B actually being the east wall of the cubicles (see prints D-7 and E-581). Before construction began, several plugs were removed from the Cell B wall and these openings, which now connect Cells I, II, III and IV with Cell B are used as "pipe tunnels" into Cell B.

Each cell has a "water-tight" stainless steel liner to make decontamination easier and to make possible the recovery of spilled solutions (E-592, E-593, E-596). The individual liners are surrounded on the north, west, south and top sides by lead shielding (Cell B wall covers the east and the concrete base pad (E-560) provides the floor. The sides facing out into the building have twelve inches of lead shielding, the inner cell walls are four inches thick (some parts of Cell IV have only ten inches of shielding). The lead is held in place by black iron plates and the weight (of roof, etc.) is supported by standard structural steel work (E-582, E-595). The whole assembly is topped by a stainless steel roof and surrounded by a lead floor to facilitate decontamination work.

Services - Lighting, Ventilation and Drainage

Illumination is provided for each cell by a single bulb (200 watt in Cells I, II and III and 20 watt in Cell IV). The control box for these lights is mounted on the west wall of Cell B, just north of the cubicles. The light fixtures, all of which are of the explosion proof type, (E-585, E-588), are mounted on removable sections of the lead shielding so that if necessary it is possible to replace a bulb while process solution is in one of the cells.

Cell ventilation is provided by four inch stainless steel pipes which extend into Cell B, putting the cubicles under the same negative pressure as Cell B.

Vessel ventilation is provided by off-gas hoods (see section on Cell I Equipment). The suction of these hoods is obtained from the A-16 vacuum system. The fumes collected by the hoods are piped into Cell B (via the open plugs mentioned above) and discharged into the A-16 header. The off-gas line has a drain and trap so that condensate in the line drains to the cell floor and not back into the vessels. Valves for these lines are located on the third level (B21) and on the second level (B20) west wall of Cell B.

External drainage around the cubicles is via a lead floor to a floor drain going to the tank farm settling basin. The stainless steel roof pan drains into Cell B sump. Cell II drains into Cell III. Cell IV drains to B22, a catch tank in Cell B. Cells I and III have no drains, the liners are emptied by jets discharging into B22 (valves on PB 4A).

Access Arrangements (For vision, Maintenance, Operation and Transfer lines)

Each cell has a periscope housing (E-584, E-593) through which a periscope specific viewer may be inserted for observing cell operations. These parts are merely stainless steel pipes cast in lead plugs so situated that they do not "directly see" any piece of process equipment thus lessening the danger of beams of radiation coming out the holes. The parts are fitted on the inside with gravity closing stainless steel doors.

The main doorways into the cells have double closure, a stainless steel seal box and Korseal gasket for waterproofing and a lead and steel door for shielding (E-589, E-592, E-590, E-593, E-588, and E-596). One inch bolts are used to draw shut the outer doors, these in turn bear on the seal boxes and the seal boxes bear on the gaskets.

The walls between Cells I and II and the wall between Cells II and III have stainless steel sleeves extending through the lead and welded to both liners. Through these sleeves are run the tygon lines which connect the glassware to the valves in Cell II. The roof of Cells I, II and III have similar sleeves. These are used for the solution and vacuum-pressure lines, for the control rods of the off-gas hood and draw off line, and for the introduction of decontaminating solutions. The sleeves in the roof not in use are filled with removable lead plugs, the others are shielded by piling lead bricks around the lines.

Decontamination of Equipment and Cells

Decontamination of the equipment is accomplished by circulation of dilute nitric acid and sodium citrate solutions through the equipment. To avoid spreading active material to lines that may not be contaminated, first two or three washes should be put through only those lines which have been used for transfers during the run. Succeeding washes, however, should be circulated through all lines, valves, and pieces of equipment.

The under side of the off-gas hoods and the off-gas lines are places that will not be cleaned by the above procedure. To decontaminate these areas it is necessary to remove the reactors (see section on Equipment Replacement for Removal Procedure) and spray sodium citrate and hot sodium carbonate solutions up against the hoods. After spraying, the hoods are "hosed down" with steam. If during this procedure the off-gas line is open, some solution and some steam will be drawn through the line thus decontaminating it.

Decontamination of the cell liners is done by the same method as the off-gas hoods. The cells are alternately sprayed with sodium citrate and sodium carbonate and sprayed with steam. Care must be taken to keep the liquid level in the liners low to prevent the solutions from draining out into the building.

CELL I EQUIPMENT DESCRIPTION

Reactor (B21R)

The reactor (ED-389) is a 4.5 liter open topped glass vessel that is best described as a large filter funnel. The filter medium is sintered glass disc of medium porosity. There is a glass semi-ball joint on the discharge or drain line under the disc which is used to connect the reactor to the transfer vessel. When air pressure is applied to the transfer vessel beneath the disc, the liquid is held above the disc and reactions may be carried on as through it were a closed bottom vessel. When the reaction is complete, vacuum is applied to the transfer vessel and the solution is filtered out of the reactor any precipitate or insolubles remaining on the filter.

The reactor receives solutions from B28, the "glass panelboard", B20T, and B24.

Transfer Vessel (B21T)

The transfer vessel (ED-389) is a five liter glass vacuum pressure pot used to transfer solutions and to apply vacuum or pressure to the underside of the reactor disc. It is equipped with wash jets by which water from the panelboard is introduced to rinse the vessel.

Off-Gas Hood

The off-gas hood (ED-396) is a hastelloy C cover which fits over the top opening of the reactor. It acts as a fume hood and collects off-gas from the reactor. It is connected to the off-gas line proper via a stainless steel semi-ball joint. This joint is in a vertical position and then reconnected to the off-gas line merely by lowering it into place (E-616).

The lines entering the reactor do so through the hood. There are two wash lines from the panelboard, one solution line from B23, one recycle line from B21T and a draw off line. The draw off line is a hastelloy C line which can be lowered through the hood down to the disc. Through this line solution can be removed if the disc should plug.

The control rod for the draw off line, the rod for raising or lowering the hood and an adjustment for the off-gas ball joint height all extend through the roof of the cell and are operated from there.

Equipment Operation

Check that all valves in Cell II are closed and that B21 is empty and ready to receive process solution. Put about two or three pounds of air pressure on the transfer vessel. This pressure is transmitted to the underside of the reactor disc and seals the bottom of the reactor. The process solution is then transferred from Cell B to B21 via B23 (see Cell B Operation for details). For each volume of process solution, add five volumes of fuming nitric acid and blow down the line. The acid is added from the panelboard and goes to the reactor via the wash jets. The transfer vessel pressure is adjusted until the excess air flowing upward through the disc is just enough to gently sparge the solution. After five minutes of agitation, the transfer vessel is put under vacuum--causing the solution in the reactor to filter through the disc into the transfer vessel. The product, which has been precipitated as the nitrate, remains on the filter disc. B21T is now vented to the atmosphere at the panelboard and B20T is placed under vacuum. The transfer line between the two vessels is opened (two valves in Cell II) and the fuming nitric waste is drawn into B20T, as are several portions of wash water which are added to B21T from the panelboard as soon as the acid transfer is finished. The transfer line between the vessels is closed and the one between B20T and B3 is opened. B20T is placed under pressure and the acid waste followed by wash water, is pushed to B3 for sampling and disposal. B20T is then vented to the atmosphere at the panelboard. B21T is again placed under two pounds of pressure. Fifty cc of distilled water are added via the wash jets and the line is blown down. Then 500 cc of cold HCl-ether (see Chemistry of Process for Concentrations) is blown into the reactor from the panelboard. After five minutes, this solution is filtered, the product precipitates on the disc as the chloride. The product precipitate on the disc is washed with three 50 cc portions of cold HCl-alcohol and then with three 50 cc portions of cold ether. The washes are blown down while the transfer vessel is under vacuum and so are drawn through the precipitate on the disc. The combined HCl-ether, HCl-alcohol, and ether wastes are transferred to B20T in the same manner as was the fuming nitric waste. B21T is now washed with several portions of distilled water as are the transfer lines leading to B3, B19, B17 and B20. The wash water used to wash the B17 line is drawn back to B20T and disposed of via one of the other lines, leaving B17 clean and empty, ready to receive product solution. One hundred cc's of distilled water are used to dissolve the product, filtered and then pushed to B17. Two 50 cc washes are put through B21R to B21T to B17. The product solution is then sampled in B17, transferred to a shipping cone and evaporated.

Chemistry of the Process

The product, as transferred from Cell B to the glassware, consists of a water solution of Barium Nitrate, Lanthanum Nitrate, Strontium Nitrate plus impurities (iron, lead, chromium, nickel). Fuming nitric acid (92% HNO₃) is used to raise the nitrate concentration above 15 normal. In this range, the Barium and Strontium are quantitatively precipitated.

$\text{Ba}(\text{NO}_3)_2 + \text{Sr}(\text{NO}_3)_2 + \text{NO}_3^- \text{KS} \longrightarrow \text{Ba}(\text{NO}_3)_2 \downarrow + \text{Sr}(\text{NO}_3)_2 \downarrow$. The iron, chromium, nickel, and some lead go out in the waste as soluble nitrates as does the major part of the Lanthanum nitrate.

The nitrate is dissolved in water and precipitated as the chloride from HCl-ether solution. Ten moles of HCl as concentrated HCl are used (416 cc) in 83 cc of ether.

$\text{Ba}(\text{NO}_3)_2 + 2 \text{HCl} \text{ (ether solution)} \longrightarrow \text{BaCl}_2 \downarrow + 2 \text{HNO}_3 \text{ (ether solution)}$. The strontium chloride formed is soluble in the HCl-ether and goes out with the waste solution.

The barium chloride is insoluble in HCl-alcohol (96 cc alcohol/4 cc con. HCl) and in ether, the washing materials used. Some lanthanum, however, is stripped by these washes. The product BaCl_2 is water soluble.

The ether and alcohol solutions are chilled before use to keep loss of reagent by evaporation to a minimum.

Operational Hints

(1) Since all the reagents used are fairly volatile, sparging should be kept at a minimum. Only enough pressure to keep the solution gently agitating should be used.

(2) Vision is an important part of operation. The method and value varying with the "state of transparency" of the glassware. Experience indicates that flow through the connector between reactor and transfer vessel can be observed long after the reactor is translucent. The completion of a transfer can best be determined by observation of the transfer line. At the end of the transfer, the lines will jerk and shake as air passes through behind the solution.

(3) To completely dispose of any solution in the transfer vessel, the lines must be equalized. While filtering, the exit transfer lines are placed under vacuum and when the transfer vessel is put under pressure, solution partly fills the lines. To return this solution to the transfer vessel, the vessel is vented to the atmosphere and the valves in the lines in question are opened. The pressures are thus equalized and the solution drains back to the vessel. This is especially important in the transfer of the product solution to B17 since such a small volume is handled.

* Although the major part of the lanthanum in most preparations behaves this way, there have been occasions when most of the lanthanum or large portions of it have precipitated at this point and have been removed as soluble chloride in the HCl-ether waste. It is suspected that presence of lead due to incomplete removal in electrolysis may be the cause of this condition.

(4) The radiation detection instruments known as HP instruments have proven to be very helpful operational tools and are used in cubicle operation quite extensively.

The Cell B monitron is used to confirm the transfer of the process solution to the cubicles. The monitron is also used to indicate the return of active material to the cell (HNO_3 waste, HCl -ether waste, product solution) by its increased reading.

The "cutie pie" is used to indicate the status at the cubicles. Some radiation is present around the base due to back scattering through the floor. This has been utilized as a transfer indication. As active material is transferred from B21T to B20T, or B20T to B3, the radiation level changes appreciably so that with a little experience it can be used as a reliable indication of solution status.

CELL I EMERGENCY AND ALTERNATE PROCEDURES

B20 and B21 are duplicate sets of equipment and even though B21 has been chosen the primary set, if both are in working order either one may be used.

Solution Trapped in Reactor

If at any time the operator finds that he has solution in the reactor which cannot be removed through the filter due to filter plugging, several alternatives are available.

The first attempt is to unplug the disc. This is done by applying pressure beneath the disc (via the transfer vessel) thus forcing material off the disc and up into the solution. If this does not succeed, the next step is to remove the product from the reactor and continue operations in the alternate set of glassware.

To remove solution from the reactor, the draw off line (a hastelloy C line which slides through the off-gas hood) is lowered down to the disc. This line is controlled by a rod extending through the roof of the cubicle. By means of vacuum and the correct valve settings in Cell II, the solution may be transferred to B24 or to either transfer vessel and processing continued.

If the attempt to remove solution via the draw off line proves unsuccessful, there is the "last chance method". The draw off line is lowered onto the disc and the disc struck a sharp blow, the objective is the piercing of the disc so that the solution can drain through the hole and into the transfer vessel.

Solution Trapped in Transfer Vessel

If there is solution trapped in the transfer vessel and it cannot be removed by pressure (due to ruptured disc, leaking ball joint, etc.) it can be removed by vacuum to the alternate transfer vessel or to B24. If all of these fail, the "last chance" method is used. One of the lead plugs is removed from the cell roof and by means of a rod or wire, the transfer vessel is broken. The solution can then be jettted from the liner to B22 and recovered from there.

Alternate Routes of Transfer

<u>Origin</u>	<u>Destination</u>	<u>Medium</u>	<u>Route</u>
B20R	B20T	Vacuum	Via disc
B20R	B20T	Vacuum	Draw off line
B20R	B20T	Gravity	Punctured disc
B20R	B21T	Vacuum	Draw off line
B20R	B24	Vacuum	Draw off line
B20T	B20R	Pressure	Recycle line
B20T	B17	Pressure	Transfer line
B20T	B24	Pressure	Transfer line
B20T	B24	Vacuum	Transfer line
B20T	B21T	Pressure	Transfer line
B20T	B21T	Vacuum	Transfer line
B20T	B19	Pressure	Transfer line
B20T	B3	Pressure	Transfer line
B20T	Cell B Sump	Pressure	B19 line, cone removed
B20T	B22	Jet	Break B20T
B21R	B21T	Vacuum	Disc
B21R	B21T	Vacuum	Draw off line
B21R	B21T	Gravity	Punctured disc
B21R	B21T	Vacuum	Draw off line
B21R	B24	Vacuum	Draw off line
B21T	B21R	Pressure	Recycle line
B21T	B17	Pressure	Transfer line
B21T	B24	Pressure	Transfer line
B21T	B20T	Pressure	Transfer line
B21T	B20T	Vacuum	Transfer line
B21T	B19	Pressure	Transfer line
B21T	B3	Pressure	B19 line, cone removed
B21T	B22	Jet	Break B21T
B24	B21R	Pressure	Draw off line
B24	B20R	Pressure	Draw off line
B24	B21T	Pressure	Transfer line
B24	B21T	Vacuum	Transfer line
B24	B20T	Pressure	Transfer line
B24	B20T	Vacuum	Transfer line
B24	B17	Pressure	Transfer line

These are only the direct transfers and it must be borne in mind that many transfers are possible by using intermediate vessels:

B20T to B17 to B8 to B23 to B20R
B21T to B24 to B17 to B8 to B23 to B19
B20T to B3 to B1 to B26, etc.

CELL 1 EQUIPMENT REPLACEMENT

The replacing of a reactor is a simple operation and should be done whenever deemed necessary. The replacing of a transfer vessel or off-gas hood is a large undertaking to be done only when absolutely essential and when relatively long periods of time are available.

Reactor Replacing

Step 1 - Disconnecting the Ball Joint

The ball joint clamp (D-619) is loosened by means of the special wrench provided (E-620). Then the halves of the joint are separated. The separating of the joint is a delicate operation and care and patience are needed. If the lower half of the joint should be broken, it would be necessary to remove and replace the transfer vessel. About one half pound of pressure is kept on the transfer vessel to aid the parting of the joint. Greater pressure increases the possibility of droplets spraying outward when the joint parts. Available tongs are then used to gently turn and twist the halves of the joint until they part.

Step 2 - Reactor Removal

The off gas hood is raised to its upper position by means of the tube extending through the cell roof. This raises the solution lines and wash lines above the top of the reactor. Check to see that the draw off line is also in the up position (the control rod, inside the hood control pipe, should now be sticking through a hole in the second level floor). Check to see that the viewing scope has been removed from the cell.

Place the reactor locator (C-614) in position with the sheet metal hooks under the pivot points of the reactor frame (E-611) and hook the reactor locator control stick over the reactor frame side arm. Hold the control in neutral position and lift the reactor by pushing down on the handle of the locator. This lifts the reactor out of the wall supports (E-611). Slowly push forward on the control stick until the reactor is in horizontal position. By means of the locator, the reactor and reactor frame may now be withdrawn from the cell. The reactor is removed from the frame by removing the two bolts which hold the frame together.

Step 3 - Reactor Reinstallation

The reactor is placed within the frame (E-611) and the frame is bolted together. The ball joint is covered with a light film of apiezon. The reactor and frame are placed on the reactor (C-614) in a horizontal position. In this position, the frame pivot points are in the sheet metal hooks of the locator and the "tail" of the frame is against the stop of the locator. Check that the hood and draw off line are in the up position and that the scope has been removed from the cell. Insert the reactor and frame into the cell with the locator. Slowly pull back on the control stick until the reactor is in a vertical position. Lower the reactor into the wall supports (E-611) and remove the locator. Lower the off-gas hood to the down position.

Step 4 - Connecting the Ball Joint

Place the two parts of the ball joint together, using available tongs. Place the ball joint clamp (D-619) over the two halves of the joint and tighten the clamp using the wrench provided (D-619).

Transfer Vessel Replacement

Step 1 - Removal of a Transfer Vessel

To remove a transfer vessel it is first necessary to remove the reactor.

The four tygon lines leading to Cell II are cut with a tree pruner or razor blade on an extension handle. The three tygon lines leading to the panelboard are cut just above the cell roof and the ends are dropped into the cell.

Right angle tongs (E-620) are used to remove the transfer vessel assembly. The assembly is gripped on the top ring stem (D-618) and the tong jaws are locked shut by means of the wing nut on the end of the handle. This leaves both hands free for maneuvering the tongs. The assembly is lifted to the height of the door and then rotated 90° so that the vessel is horizontal. The assembly is then removed from the cell, top first.

The vessel is removed from the supports by removing the two bolts holding the top ring together and then removing the top ring from the ring guide (D-618).

Step 2 - Transfer Vessel Installation

The transfer vessel is fastened into the supports (D-618). The tygon lines leading to and from the transfer vessel are fastened to it (four to Cell II and three to the panelboard). The connector (ED-389) which joins the reactor to the transfer vessel is connected to the transfer vessel. The loose ends of the tygon lines are fastened to strings or wires

which have been strung through the parts in the roof and wall through which the tygon lines are to go. The reactor assembly is now inserted into the cell. Whenever possible, this should be done by hand but it may be done using tongs if the radiation level is too high. The assembly is inserted in a horizontal position, bottom first. When it is in the cell it is rotated and lowered to the floor of the cell. The tygon lines are pulled to their destinations by means of the strings or wires attached to them. The connector between reactor and transfer vessel is inserted in its wall support (E-612) and the tygon lines are connected to their destinations in Cell II and at the panelboard.

Cell I - Off-gas Hood Replacement

Step 1 - Removal of the Hood

The reactor must first be removed.

The tygon lines leading to the hood are cut (two from Cell II, one from Cell B, and two from the panelboard). The off-gas line drain is removed. (1/8 inch line, union in the cell). The off-gas line is disconnected at the union in the cell (P-1 of E-616). The reactor wall support (E-612) is removed. The off-gas line adjustment rod (P-6 of E-616) is disconnected. This can usually be done by turning the handle of the rod above the cell until the nut on the lower end falls off--this can be done only if the transfer vessel has been removed, otherwise the nut must be removed from inside the cell. The hood may now be lowered to door level by means of the hood elevating pipe (P-11 of E-616). The control rod for the draw off line (P-12 of E-616) is disconnected by turning the end of the rod above the cell until it is unscrewed from its mount. The hood elevating line is unfastened (by removal of a 1/4 inch nut at the offset (P-11 of E-616) in the line. The hood is now loose and may be removed from the cell.

Step 2 - Insertion of the Hood

The tygon lines leading to the hood are connected to it. The hood is placed in the cell and suspended from the elevator pipe (by bolting back together at the offset). The control rod for the off-gas line is screwed into its fastening. By means of the elevating mechanism the hood is raised until the off-gas line bracket (P-2 of E-616) engages its adjustment rod. The rod is fastened to the bracket. The hood position is now adjusted so that the two halves of the union in the off-gas line are aligned. The union is tightened and the condensate trap is then installed and reconnected.

CELL II

Cell II - Equipment Description

Cell II contains the sixteen hastelloy C valves (ED-57) which are used in conjunction with the glassware. The valves are of semi-

needle type construction. They are mounted on stainless steel racks (E-604) which are fastened to the cell liner. The valves are in line with parts in the shielding of the cell so that they may be operated by extension handles (ED-361) from the outside of the cell.

Cell II - Purpose and Functions

Cell II is a junction cell where most of the connecting and all of the manifolding of tygon lines is done. During normal operation it is merely a valve box but under emergency conditions it gives access to the valves and transfer lines so that it is possible to improvise routes or means of transfer.

Cell II - Maintenance

The valves are delicate pieces of equipment and must be operated with care. But even with the best care occasional maintenance is required. Whenever the valves are accessible, as when a transfer vessel is being replaced it is advisable to check the valves. Repairing them usually consists of repacking and relapping.

CELL III

Cell III is a duplicate of Cell I and contains B20, a duplicate of B21. All the information in the section on Cell I is applicable to Cell III.

CELL IV

Equipment Description

Cell IV contains B25, a sintered glass disc used to remove insoluble material from process solutions. It is used in conjunction with B26 (head pot) and B27 (receiver). The disc is a standard 90 mm sintered glass filter, coarse grade, connected to the rest of the system via glass semi-ball joints (A-617). The cell also contains three of the valves necessary for operation; one between B26 and B25, one between B25 outlet and B27, and one between B25 inlet and B27.

Cell IV Normal Operation

Line vacuum (18") is applied to B27 (at PB-4A). The valve between B27 and B25 (the disc) is opened, thus placing B25 under suction. Then the valve between B26 and B25 is opened allowing the slurry to flow onto the disc. The path of the liquid is therefore out of B26, through the filter of B25 and into B27. The entire filtration should be observed with the periscope in the cell to determine if the system is leaking as well as to determine when filtration is complete. When filtration is complete, valves B26 to B25, and B25 to B27 are closed, vacuum supply to B27 is shut off, and B27 is vented.

Cell IV Emergency Operation

Even though a leak may develop in the system, operation is possible. In this case, after B25 has been placed under suction, the valve between B26 and B25 is only partially opened. As a result, B25 remains under vacuum and air is sucked in at the leak rather than process solution flowing out.

In the event that the feed solution contains an unusually large amount of insoluble material, the disc may become completely plugged. To transfer the solution remaining in B26 and B25 to B27, the valve between B25 inlet and B27 is opened and B25 is by-passed (E-613).

If B25 should break or should a large amount of process solution escape through a leak, the material may be recovered by wading out the cell liner and then recovering the material from B22 to which it drains. (This is a small drain and large amounts of liquid should not be added as there is danger of flooding the liner).

Cell IV Equipment Replacement

B25 is an expendable item to be replaced as often as necessary so as to eliminate, if possible, the danger of a disc plugging during a run.

The ball joint clamps (ED-388) are removed with a pair of right angle tongs (E-620). The entire assembly is then lifted out with tongs available.

The new assembly is set in place and the ball joint clamps replaced with the same tongs used for removal. The important factor in replacement is "tong technique".

B20 and B21 CONTROL BOARD

Description

The panelboard for operation of the glass equipment in Cells I and III is located on the second level, just above the cubicles proper. The panelboard contains the controls for applying vacuum or pressure to the transfer vessels and the head pots from which reagents and washes are introduced to the glassware.

The vacuum pressure lines contain traps filled with glass wool and a dessicant to absorb any "hot" vapors that might be drawn from the cell.

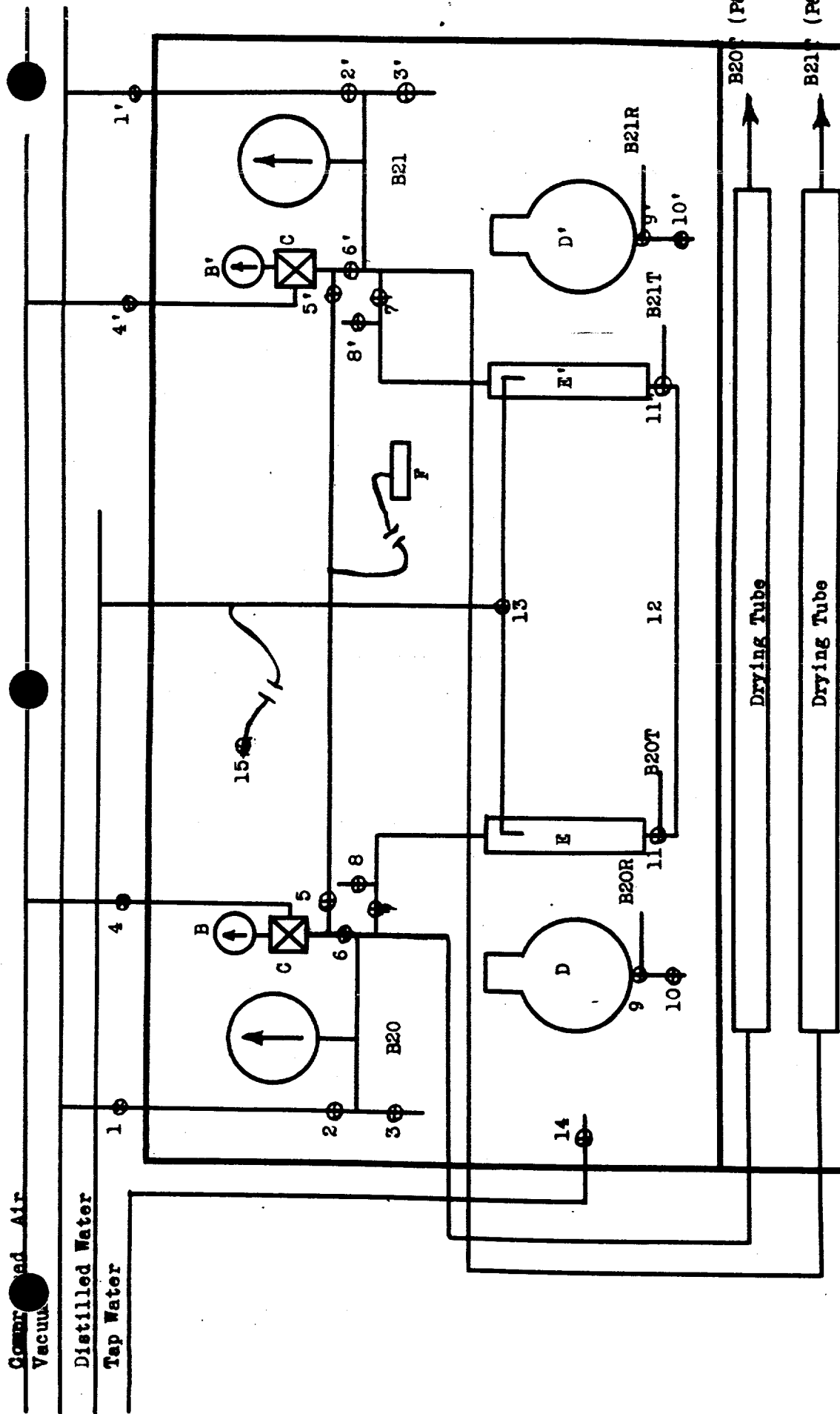
Operation (Refer to Drawing #P-10)

To apply pressure to a transfer vessel, the vent valve (No. 5) is closed and the pressure valve (No. 6) is opened. The required pressure is then applied by means of the Airco pressure reducer (C).

To apply vacuum to a transfer vessel (as for a filtration) the vent and pressure valves (3 and 6) are closed and the vacuum valve (2) is opened. Both vacuum and pressure being applied are shown on gage A.

To add a reagent to the reactor the material is put in the head pot D, the drain valve (9) is opened and the solution will drain to the reactor. To induce good washing action, the pusher (F) is used to apply pressure to the head pot and to force the reagent into the reactor under pressure. Pressure is applied to the pusher F from the pressure reducer via valve 5.

A glass pressure pot (E) is used to supply wash water to the transfer vessel. This is necessary as much of the washing is done with the transfer vessel under pressure. To fill the pressure pot, the drain valve (11) is closed, the vent (8) is opened and water is added via valve (13). To send the water into the transfer vessel the vent is closed, pressure is applied to the pot via the pressure reducer and valve 7, and the drain valve is opened. When all the water is gone, the drain and pressure valves (7 and 11) are closed and the pot (8) vented.



1. Vac. header to P.B.
2. Vac. to Tr. vessel
3. Tr. vessel vent
4. Pr. header to P.B.
5. Air to "pusher" F
6. Pr. to Tr. vessel
7. Pr. to pot E.
8. Vent of pot E

9. Head pot to reactor
10. Head pot drain
11. Pr. pot to Tr. vessel
12. Pr. pot drain
13. Distilled water to pr. pot
14. Tap water
15. Water line to head pots

- A. Compound gage
- B. Pressure gage
- C. Pressure regulator
- D. Head pot for solutions to the reactor.
- E. Pr. pot for wash water to the Tr. vessel
- F. Pusher, to apply pressure on the head pots and force solution out

Drawing No. P-10

EQUIPMENT FLOWSHEET
FOR GLASS PANEL BOARD

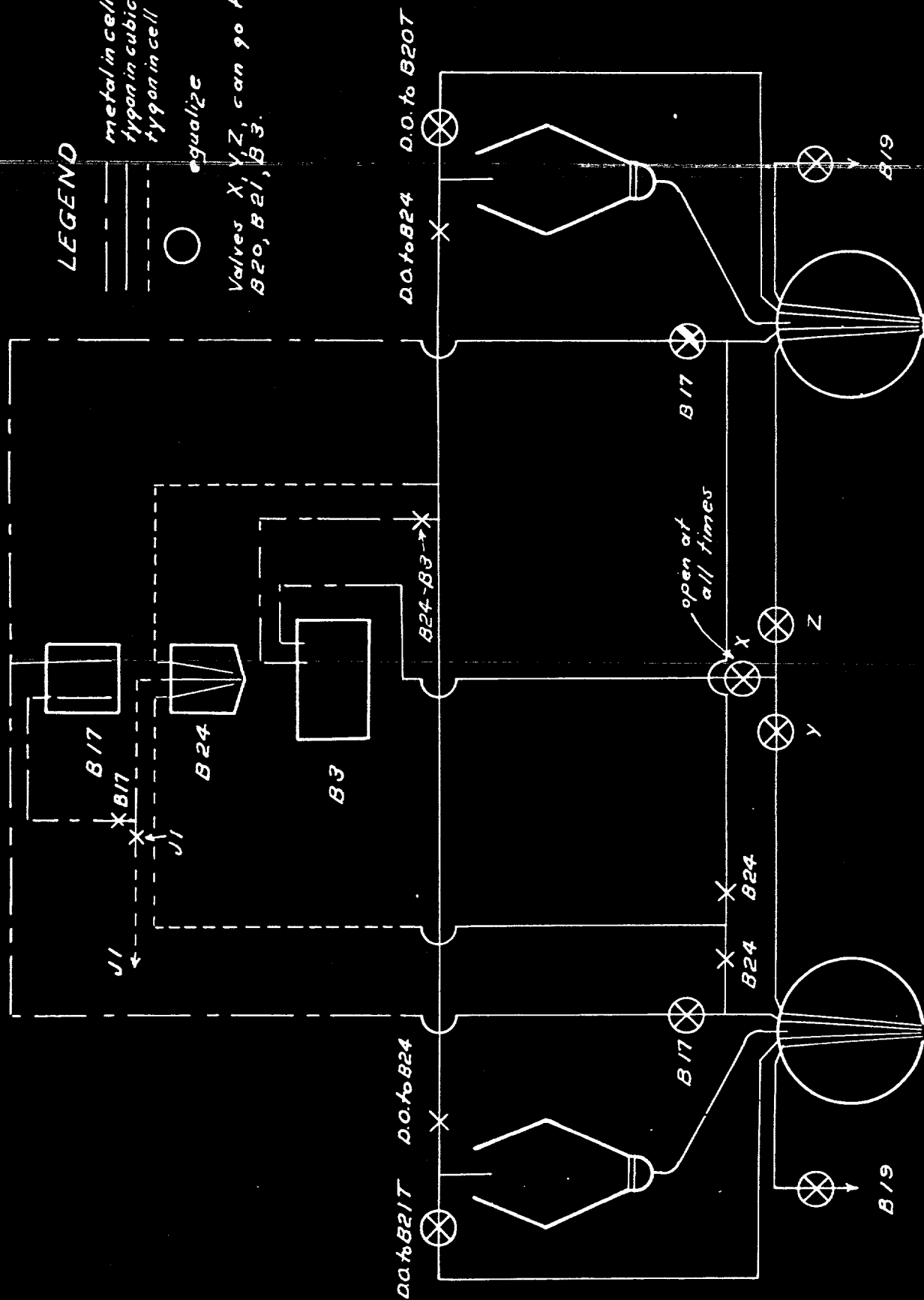
LEGEND

metal in cell
tygon in cubicles
tygon in cell



equalize

Valves X, Y, Z, can go to
B20, B21, B3.



VENTILATION

Three separate ventilating systems are in use in 706-D for the purpose of eliminating radioactive gases generated in the process. Vessels A-1 and A-5 in Cell A are serviced by a jet operated system discharging into the 205 area stack. This system is aided by the original stack blower installation in the 205 area. Other process vessels in Cells A and B discharge off-gasses through the A-16 system which utilizes a centrifugal blower discharging into the 205 stack. A third system keeps Cell A and B at a slight negative pressure with respect to atmospheric pressure and disposes of any gases which escape the first two systems inside the Cells.

An alarm system which flashes a red light and sets off a buzzer was installed in the operating area to give warning whenever either 706-D stack blower or the A-16 blower stops running.

A4-205 OFF-GAS SYSTEM

The A4-205 system is a 2" stainless steel line which is arranged inside Cell A as shown on Figure P6. The A4-205 off-gas line leaves Cell A through the east wall by way of plug AE-F2, then on through the east building wall where it drops to ground level. From there it runs north 18" under ground following the building wall, turning west at the corner of the building, still under ground, into a concrete junction pit where it connects into an approximately 10 gallon condensate collecting pot. Leaving the pit, it continues west, still under ground connecting into the "Christmas Tree" shown in Figure P7. From there it runs north eventually typing into the 205 off-gas system.

Operation of System

A Croll-Reynolds jet (205-211H-213) made of 18-8 stainless steel provides the vacuum for the A4-205 system. It provides a maximum of 4" Hg or 50" of H₂O at the jet. It has a capacity of 150 cfm and discharges into a waste gas disposal stack (205-903-BPF) where a dilution air blower (205-901-BPF-29002) having a capacity of 20,000 cfm dilutes the radioactive gases from the jet and discharges them into the atmosphere. The jet and blower are in operation continuously.

Since the greater length of this off-gas line is exposed to atmospheric conditions, condensation takes place during cold weather. This condensate collects in the "Christmas Tree" and in the catch pot in the junction pit. Removal of collected liquids in the catch pot in the junction pit is done by means of a jet discharging into the W-11 line. Emptying the "Christmas Tree" is a more complicated procedure which is done as follows: (Refer to Figure P7).

1) Check to make certain valves 6 and 7 are closed. (These valves are only to be open when 706-G requests it of 706-D supervision. However, proper draining of this system requires these valves to be closed during draining operation).

2) Check to make certain that valves 2, 4, 5 and 6 are also closed.

3) Close valve 3.

4) After several minutes close valve 1.

5) Open valve 2.

6) Open valve 4 and allow to remain open until no liquid is seen issuing from Christmas Tree.

7) Close valve 4.

8) Close valve 2.

9) Open valve 1.

10) Repeat steps 4 through 9 until no more liquid issues from Christmas Tree when valve 4 is opened. When liquid doesn't appear, the system is drained.

11) To put system back into operation, open valve 3. The only valves left open for off-gas removal during operation are valves 1 and 3. All other valves should be kept closed.

A16 OFF-GAS SYSTEM

Most of the gas evolution in the process occurs in A1 or A5 which vessels are exhausted by means of the A4-205 off-gas system. The A16 system keeps other process vessels in Cells A and B under slight vacuum to dispose of radioactive gases and vapors formed in these vessels.

The principle parts of this system are as follows:

1) Primary blower

Spencer Gas Booster

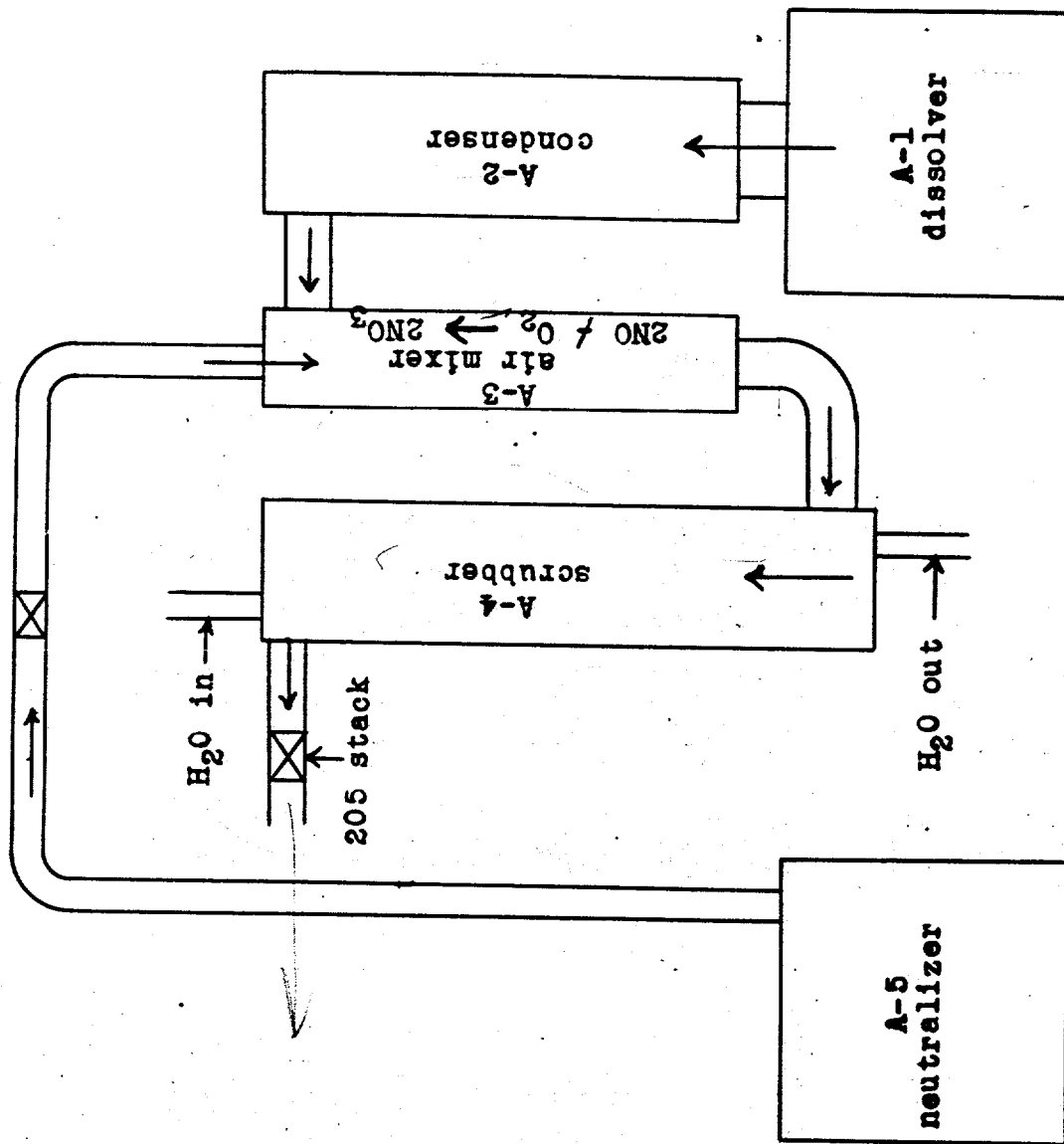
CL 18802
Lot 42049
Ser. 6408
H.P. 2.5

2) Emergency blower

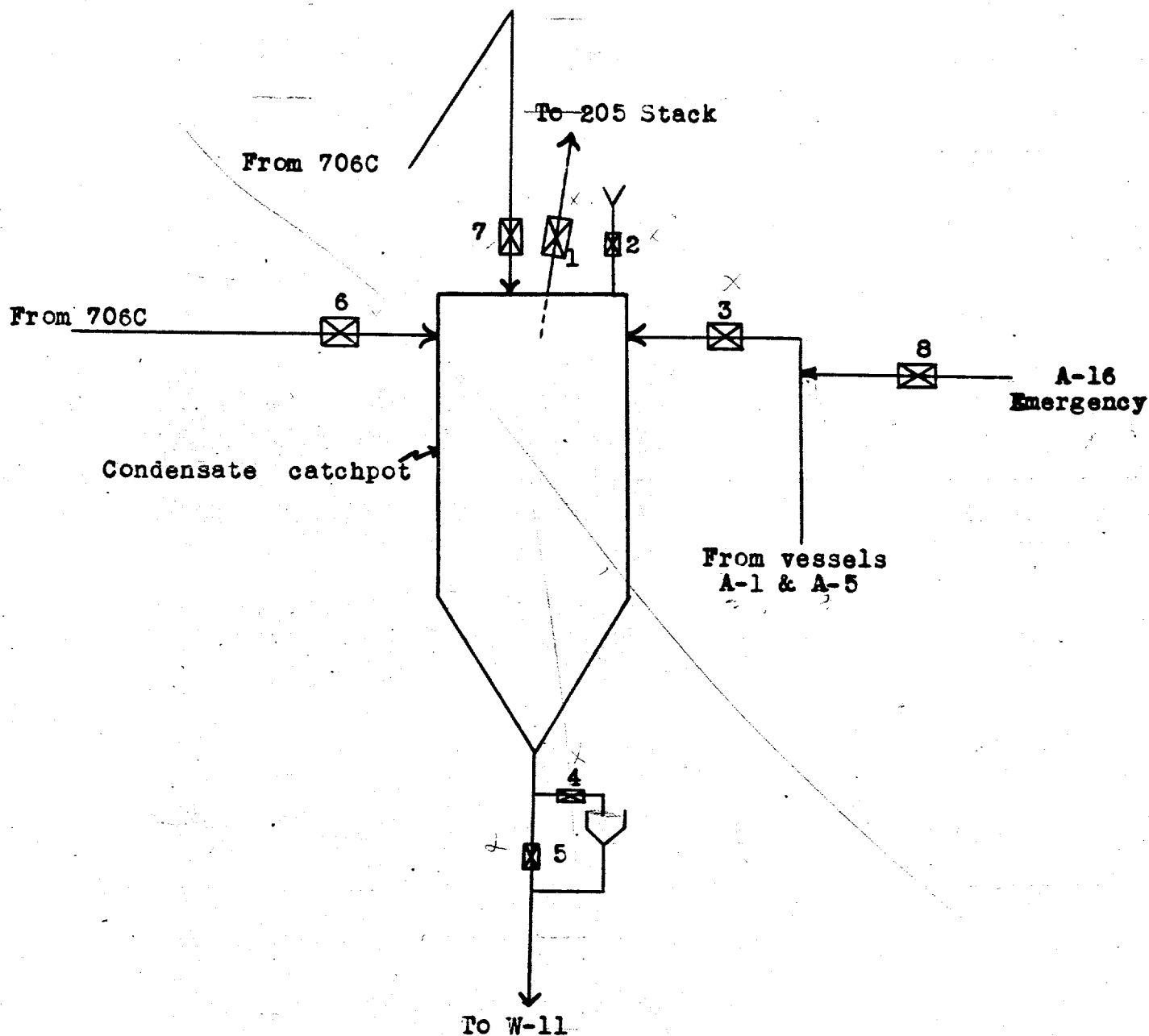
Roots, Connerville

Type AF
Ser. 4308-328
CL 18801
H.P. 1.5
Cfm 150

A-4--205
OFF-GAS SYSTEM



DRAWING NO. P6
REF 2-21-46



CHRISTMAS TREE

Located above ground outside NW corner 706D

Operation of System

The centrifugal blower is on at all times during normal operations; in case of emergency the auxilliary blower is used or the connecting line from A16 system to the Christmas Tree is put into operation by opening one valve near the fan house and one at the Christmas Tree. Electrical controls for all blowers are located in the 706-D fan house.

Once per shift the cyclone separator is drained (plug AW-K12). Also drained once per shift is the low point in the A16 line (N.E. 706-D) and the pan underneath the centrifugal blower. This latter drain valve is located on the south wall of the fan house.

A tabulated description of the A16 system in detail taken from the memo of W.P. Bigler to file of 8/24/45 follows with necessary revisions made since the date of writing:

TABLE I

List of Vessels Serviced by the A16 Off-gas System
and the Location of the Control Valves

Cell	Vessel	Location of Control Valve
A	A6	AE-B4
A	A8, A9, A-11	Top of Cell A
B	A12 (B1 condenser), B3, B12, B17, B18; (B3 condenser), B19, B26.	Top of Cell B
B	B10	BE-C3
B	B20	BT-C1
B	B21	Top of Cell B

~~SECRET~~

TABLE II

List of Equipment in the A16 Off-gas System and
A Description of Their Uses

Valve No.	Label	Valve Location	Use	Open for Operation No. a
1	Water to A16	Panelboard #2	Water through the rotometer to A16	1, 2, 3, 5
2	Cyclone Separator Drain	A7-K12	to periodically drain system	4
3	A16 Drain	Top of Cell A	to close off for back filling A16	1, 2, 3, 4
4	A16 Intake	AE-F1	to close off for back-filling pipes to A16	1, 2, 3, 4
5	None	(East Side of Cell A)	adding solutions above valve #4	5
6	Air	(2nd floor)	positive displacement of NH ₃ through the system	1, 2, 3
7	NH ₃	" "	Control of gas from tanks through the orifice to A16	1, 2, 3
8	NH ₃ By-pass	" "	adding an excess of NH₃ to off-gas system down stream from A16	
9	A16-205	N. of 706-C	(If both blowers fail, this is the emergency system)	3
10	A16-205	S of Fan House	" "	3
11	None	N.E. 706-D	for rinsing out off-gas low point	5
12	A16-711	N.E. 706-D	for draining off-gas low point	4, 5
13	Separator Drain	Fan House	for draining off-gas separator	5
14	Pan Drain	S. Side of blower wall	to drain the pan under the centrifugal blower	4, 5
15	Cent. Blower Intake	S. side of blower wall	Open when operating the centrifugal blower	1, 4, 5

* See Table III for Explanation of Operation No.

~~SECRET~~

TABLE II
(Continued)

Valve No.	Label	Valve Location	Use	Open for Operation No. *
16	Cent. Blower Exhaust	E. Side of Blower Wall	Open when operating Centrifugal blower	1, 4, 5
17	Displ. Blower Intake	Fan House	Open for operating displacement blower	2, 4
18	Displ. Blower Exhaust	E. Side of Blower wall	Open for operating displacement blower	2, 4
19	Cent. Blower Drain	S. Side of Blower wall	to drain the 4 suction in the centrifugal blower	
20	Water to Separator	In Fan House	Water to the separator and system for rinsing and filling for decontamination	4, 5
21	Water to A16-205 line		For decontaminating A16-205 line	5
22	A16-706-D		Open for discharging off-gases into 706-D stack	2
23	A16-205		Open for discharging off-gases to 205 stack.	1
24	A16-205 drain		For draining any liquid which may be in line	4, 5
25	A16-205 Spore drain		" " "	4, 5

When Centrifugal blower fails.
NORMAL OPS

* See Table III for Explanation of Operation No.

TABLE III

Explanation of Operation Numbers Listed in Table II

Number	
1.	Normal operation using the centrifuge blower which is the main blower.
2.	Standby operation, when Operation #1 fails, uses the positive displacement blower.
3.	If both operations #1 and #2 fail, the off-gas is pulled by the 205 jet at the stack.
4.	During operation #1, #2, or #3, the system is periodically drained.
5.	For decontamination during a shut-down procedure, solutions are added and removed at various points.

Cell Ventilation System

Separate intake ducts (18" x 24") for Cells A and B are located on the east wall of 706-D and a common discharge duct (36" id) leaves the cells at ground level, also from the east side of the building from where it continues to the 706-D stack blower in the fan house. Heating coils in the intake ducts keep the air warmed during cold weather.

Motor controls are located in the fan house and manometers located on PB-1 and PB-4A give indication of cell vacuum.

706-D Stack Blower Specifications

Buffalo Forge #8 type SL Fan
15,400 cfm
2" S.P.
745 R.P.M.
7.4 BHP

Reference Drawing - BPF 65160
CL-706D-98

Details of the cell ventilation system may be found ⁱⁿ drawings CL-706D-28, CL-706D-36, CL-706D-175.

AUGUST 28, 1947

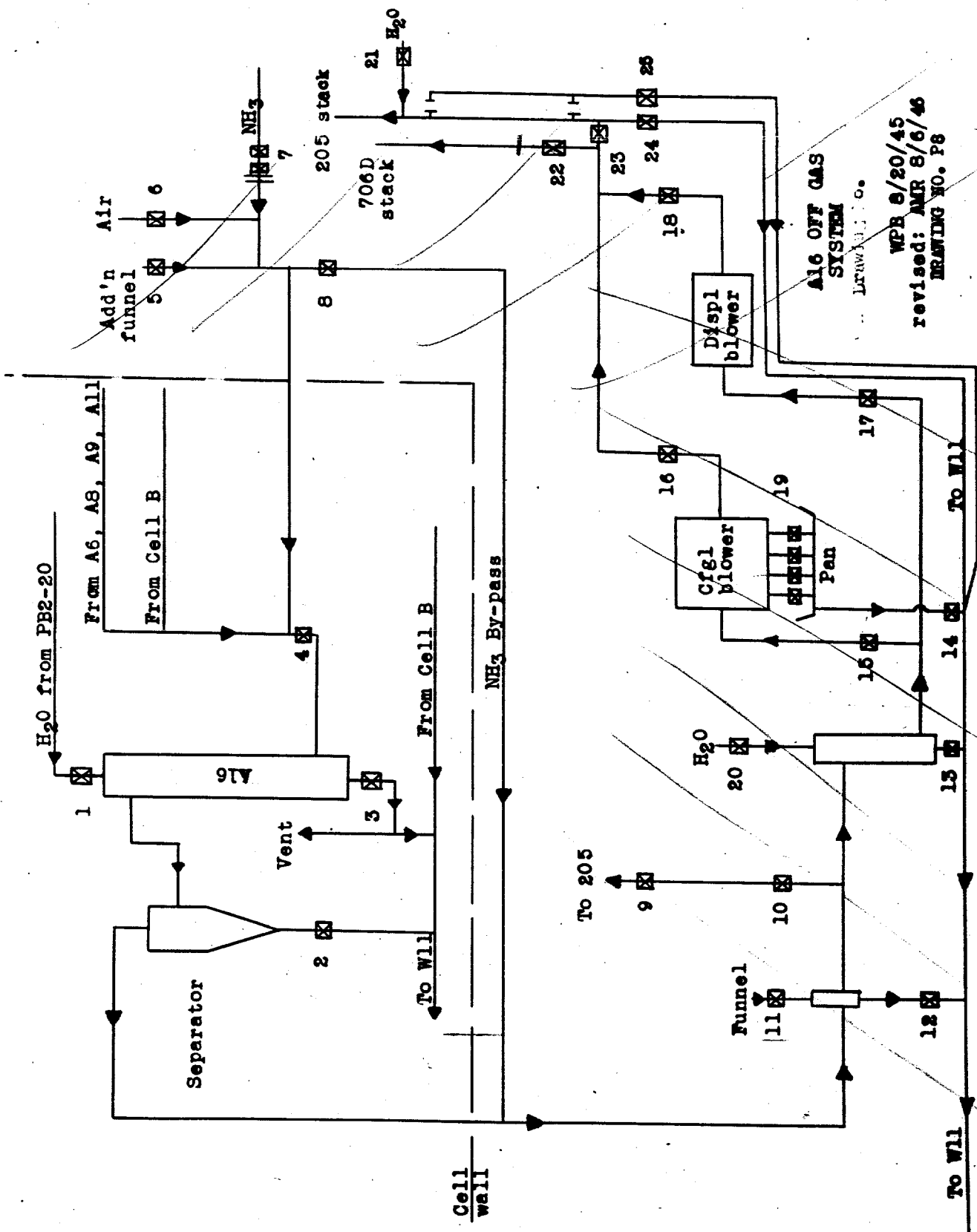
TO: Emlet, Witkowski, Whitney, Gissel, Blauer, Pressly,
Rimshaw, Thompson, Russell, King, Vallado, Perry,
Skraba and Pennington.

FROM: H. Blauer

In Barium Process Manual on Page 3, paragraph 2,
under Special Exposure Rules, add to the sentence "No part
of the body to be knowingly exposed to radiation exceeding
6 r/hr (tolerance time - 30 seconds)", except when 6 P
sample is taken.

H. Blauer

Attached is copy of new cubicle lines.



A16 OFF GAS
SYSTEM

Drawn by: G. O.

WPB 8/20/45
revised: AMR 8/6/46
DRAWING NO. P8

SOLUTION MAKE-UPMetal Waste Neutralizing Solution

- | | | |
|---|--------------|--------|
| 1) Water----- | 1760 #s----- | 24" |
| 2) Soda Ash (Na_2CO_3)----- | 575 #s----- | 6 bags |
| 3) Trisodium Phosphate----- | 230 #s----- | 2.5 " |

The above solution is made up in Tank M1, and then jetted to A5 to neutralize extraction metal waste. Use 7" of solution in A5 for every 10 slugs dissolved.

35% NaOH1) Using 98% Flake NaOH

- a) For every 100 #s Flake Caustic, use 1.4" H_2O in M1.
- b) Jet to M11 and adjust to 35% (Sp.Gr. 1.38) by adding dilution water.

2) Using 35-50% NaOH From Drums

- a) The NaOH is jetted directly to M11 and adjusted to 35% (Sp.Gr. 1.38) by adding dilution water.
- b) After emptying drum rinse with water and jet to M11.

The above solution is used in removing aluminum jackets from slugs prior to dissolving.

1) From 35% NaOH in M11

- a) For each 1" of 35% NaOH in M10 make 9" solution in M10.
- b) Spurge well.

2) From NaOH (approximately 40%) in drums

- a) Each drum of solution makes 20" of 4% NaOH in M10, or
- b) Each drum of solution will make 8125 #s 4% NaOH in M10.

NaOH is used in A4 scrubber during dissolving to remove NO_2 , and iodine fumes that are released to off-gas system.

25% HNO_3

- a) 1 Bottle HNO_3 (c.p.) ----- 7.0 #¹s
 b) 5760 cc distilled H_2O ----- 12.6 #¹s
 Sp. Gr. 1.15 ----- 19.6 #¹s
 8.9 Kg. ----- 7.73 Liters

The above solution is used in removing PbO_2 following electrolysis.

40% K_2CO_3

- | | |
|--|-------------|
| a) 1 - 8 $\frac{1}{2}$ bottle K_2CO_3 (anhydrous)----- | 2270 gms. |
| b) 3890 ml distilled H_2O ----- | 3390 gms. |
| Sp. Gr. 1.41 | 5560 gms. |
| | 4.02 liters |

The above solution is used in the metathesis of extraction cake.

HCl-Ether Solution

- a) 85 ml Ether
b) 415 ml HCl (37%)

The above solution is used in the precipitation of the BaCl_2 product only.

1% NaOH

- a) 24 L. H_2O
b) 2409 gms. NaOH

The above solution is used in the neutralization of the fuming nitric waste.

Ethanol-HCl Solution

- a) 6 ml HCl (37%).
b) 145 ml absolute Ethanol

The above solution is used in washing the BaCl_2 product cake.

20% Lead Nitrate Solution

- a) 5 lb. $\text{Pb}(\text{NO}_3)_2$
b) 20 lb. distilled H_2O

The above solution is used as a carrier in BaSO_4 precipitation.

ANALYTICAL PROCEDURESSAMPLING

All of the samples presented to the laboratory, with the exception of the final product (17P) sample, are taken in 5 ml. graduated centrifuge cones. The samples in the various blisters are set to deliver to the cones a sufficient volume for analysis.

The 17P sample is taken in a special "bucket" sampler, unless more than four hours have elapsed since process last separation time, in which case self-filling capillary pipettes are used, because the growth of lanthanum gamma activity is so great as to make handling of the larger bucket sample dangerous. The bucket sampler consists of a sealed glass tube with two holes in the side near the lower (sealed) end, holding about 0.2 ml., mounted in the end of a stainless steel sleeve (about 1-3/8" of glass exposed), the opposite end of which is adapted to fit the B17 probe. The sampler is simply placed on the end of the probe, lowered into B17 until the bucket is submerged and filled, then withdrawn. The capillary pipette consists of a calibrated glass capillary tip of 4-10 lambda (0.004-0.01 ml) capacity sealed into a glass sleeve, which in turn is cemented into a stainless steel jacket of the same type as that used on the bucket. This is used very much in the same way as the bucket sampler, by lowering into B17 until the tip touches the liquid, thereby filling the pipette, and then withdrawing.

A sample is delivered to the South Analytical laboratory in a covered lead carrier, where it is removed by a chemist, and the carrier is returned to the operator. At this time the chemist examines the sample for solid matter, etc., and if such undesirable material is found, he requests a new sample.

Handling of original samples is hazardous because of the high radiation from them. The lead walls of the South Lab. barricades, supplemented by bricks where necessary, furnish adequate body shielding for the chemists. The danger to the hands is decreased by the use of a remote-control sampling device, in which a motor-actuated worm gear draws up the plunger in a conventional micro pipette control (Microchemical Specialties Company), filling a micro pipette with sample, which is then discharged into a volumetric flask and rinsed into the same flask, forming the "first dilution" for barium determination. A thick lead barricade furnishes shielding, and a small periscope facilitates observation of the pipette. Beyond the first dilution, pipetting is done by hand.

Original samples and first dilutions are stored in a vault consisting of twelve sections closed by individual lead doors. The protection afforded by this device is such that with the vault practically filled the radiation outside is negligible.

South Lab. floor contamination presents something of a problem, due to small spills of active material in running the 6F lead determination, etc. Twice the floor has been rather seriously contaminated, necessitating the wearing of rubbers, but no difficulty has been experienced in decontamination. The barricade floors are usually somewhat contaminated, but washes with water and nitric acid remove this easily.

RADIOCHEMICAL ANALYSES

Radiochemical Determination of Ba¹⁴⁰

Barium activity in 706-D process solutions is determined by the usual radiochemical hydrochloric acid-ether method (1, 2).

A 1-ml sample is withdrawn from the proper 2N nitric acid dilution of the original sample (dilution calculated to give an accurately measurable counting rate of barium), and placed in a 40 ml centrifuge tube. 2 ml of standardized barium chloride ("barium carrier") and about 35 ml of HCl-ether (five parts concentrated HCl to one part of ether by volume) are added. On cooling in cold tap water or ice, with stirring, a precipitate of $\text{BaCl}_2 \cdot \text{H}_2\text{O}$ is obtained. This is centrifuged out, and the supernatant liquid is discarded. The barium precipitate is dissolved in about 1 ml of water, and reprecipitated by addition of about 15 ml of HCl-ether. Dissolving and reprecipitation are repeated; the precipitate is slurried with about 5 ml of HCl-alcohol (96% ethanol, 4% conc. HCl), and filtered on a tared 5/8" piece of No. 1 filter paper in a Hirsch funnel. The precipitate is then washed with about 5 ml of HCl-alcohol, then with 3-5 ml portions of ether. After the ether has filtered through, air is drawn through the cake for 30 seconds to remove residual ether. The paper with precipitate is then reweighed to determine the chemical yield of carrier added. It is mounted in the center of a solid $2\frac{1}{2}'' \times 3\frac{1}{4}''$ card, covered with cellophane, and barium betas from the sample are counted on the third shelf of a standard Geiger-Mueller counter. The count is taken within one-half hour of the last HCl-ether precipitation, because growth of La activity gives a measurably high result after that time. The count is corrected for coincidence, background, standard, and chemical yield. (2) By dividing by the sample size taken (dilution), the amount of Ba in counts per minute per ml is obtained. A figure for total Curies of Ba is calculated by the formula

$$\text{No. of Curies} = \frac{\text{cts/min/ml} \times \text{process vol. in ml}}{2.22 \times 10^{10} \times \text{geometry of counter}}$$

The procedure for Ba in 706-D is a somewhat simplified version of that recommended by Hume and Glendennin (2), and by Hume, Nelson, and Goldridge for 706-C (5). The following changes were made: (1) filter papers are used without previous washing with alcohol and ether; (2) drawing air through the filter cake for 20 seconds has been substituting for a seven-minute vacuum desiccation; (3) metathesis and scavenging of extraction wastes have been

abandoned. The reason for all these changes is the same - the error introduced is smaller than the errors in sampling, and the other analytical errors, and errors introduced by the first and second procedures tend to cancel that from the third (3).

Other Radiochemical Analyses

Strontium (Sr^{89}) can be run on request.

Special samples for determination of gross beta or gamma counts per ml are sometimes received. These are run by simply evaporating on a one-inch watch glass the proper volume, mounting in a 1-1/16" hole in the center of a $2\frac{1}{2}'' \times 3\frac{1}{4}''$ card, covering with cellophane, and counting on any desired shelf of the Geiger-Mueller counter (2).

ORDINARY CHEMICAL ANALYSES

Uranium

Uranium in dissolver solutions is determined colorimetrically, taking advantage of the fact that uranyl ion develops a brownish-yellow color with sodium salicylate in slightly alkaline solution. The intensity of this color is measured against a blank of all reagents on a Coleman Universal Spectrophotometer, Model 11 (used for all colorimetric work in this lab.), and the amount of U corresponding to the transmittance determined from a standard curve (made by running known amounts of U in an identical manner). The uranium concentration is calculated as grams/ml; then the number of slugs dissolved is calculated by the formula

$$\text{No. of slugs} = \frac{\text{g/ml of U} \times \text{process vol. in ml}}{1.10 \times 10^3}$$

1.10×10^3 is an empirical weight of U per slug determined for the 706-D dissolver in dummy runs from the number of slugs known to be dissolved (1).

Lead

Lead is determined occasionally on extraction wastes, and frequently on GP samples. The method is that devised by Boldridge, Nelson, and Hume (4), measuring spectrophotometrically the intensity of the color developed by the lead in the presence of the organic reagent "dithizone" (diphenylthio-carbazone). The lead is extracted from a pipetted sample by a dithizone solution in chloroform. For this extraction, a specially built mechanical shaker is used, which holds one separatory funnel. The intensity of color developed in the dithizone solution is measured by the spectrophotometer, and the amount of lead in the sample read from a standard curve, as for uranium. The calculation is very similar to that for uranium (1).

Additional Ionic Analyses

The laboratory has facilities for colorimetric analyses for iron, chromium, and nickel, which are very rarely done. Occasionally acid strength must be run on process solutions. This is done by direct sodium hydroxide titration of pipetted sample, or, in case of dissolver solutions by a special method involving precipitation of the uranium with potassium ferrocyanide, then titration of the supernatant liquid. pH is sometimes determined by means of pH paper to check operating conditions (4).

"Make-up" Solutions and Essential Materials

Samples of solutions to be used in the process are often sent to the lab. These include 40% potassium carbonate (run by titration with standard HCl), 20% lead nitrate (by specific gravity), and occasionally other materials, such as sodium hydroxide for assay (HCl titration), nitric acid for lead or iron, etc. Specification analyses are sometimes run on shipments of essential materials such as nitric or sulfuric acid (4).

Spectrographic Analyses

Spectrographic analyses for barium, lead, iron, chromium, nickel, and strontium are run on 17P samples by a Chemistry Division spectroscopist. Five lambda of the 17P sample (or one capillary pipette) is evaporated on a copper electrode by means of an infra-red lamp. This sample is transported to the spectrographic lab. in a special lead carrier. There a spark spectrogram is taken, and the amounts of impurities and of "chemical" barium found by comparison with a standard spectrogram. In recent runs, a "blank" has been run to eliminate high results due to contaminated electrodes and reagents. Also a dilution has been made in order to determine barium more accurately than with the five-lambda sample of original solution.

RADIATION MEASUREMENT ("Skyshine")

As a check on the radiochemical analysis for barium, measurements of the gamma radiation from its lanthanum daughter are made (7) (8).

All cement blocks are removed from the Cell B chimney and a one-inch plate of iron is placed over the opening. The "G.E. Chamber" (ionization chamber) is placed in a marked position on the plate. The G.E. Chamber is connected to a Micromax recorder, which gives instantaneous readings of roentgens/hour of gamma radiation coming through the iron plate. The evaporated product in the cone is pushed to a definite position under the chimney, and readings of radiation are made at various times after process last separation time. The reading at "LST plus 20 hours" is observed or obtained by interpolation. A plot of radiation reading at this time against number of Curies of barium at LST is available. The error in determination of barium by this method is about $\pm 10\%$.

AUXILIARY EQUIPMENT

AUXILIARY EQUIPMENT

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Drawing Numbers

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SOLUTION MAKE-UP AREAS

The solution make-up areas consist of the following:

- (1) The east loading platform where chemicals are unloaded from trucks in carboys and drums and stored here until they are ready for use. Also on this platform, near the building, are two tanks in which 33% and 4% caustic are stored.
- (2) Room #10, the make-up room, in the S.E. corner of the first floor. The make-up and transfer of all process chemicals which are used in large quantities originates in this room. Liquid chemicals are transferred from carboys or drums into the tanks located here and transferred to storage tanks, located on the third floor or the east platform (4% or 33% caustic), by means of pumps or jets.
- (3) The head tanks, located on the 3rd floor E. side of Cell A, are used for intermediate storage of chemicals prior to their use in the cell process vessels. The chemicals are weighed in the scale tanks located below the head tanks and then run through a series of funnels into the process vessels.

A complete list of solution make-up equipment, the use of each piece, and the methods of transfer are described in the following tables and sketches. For further solution make-up instructions, refer to section titled "Solution Make-up".

TABLE I

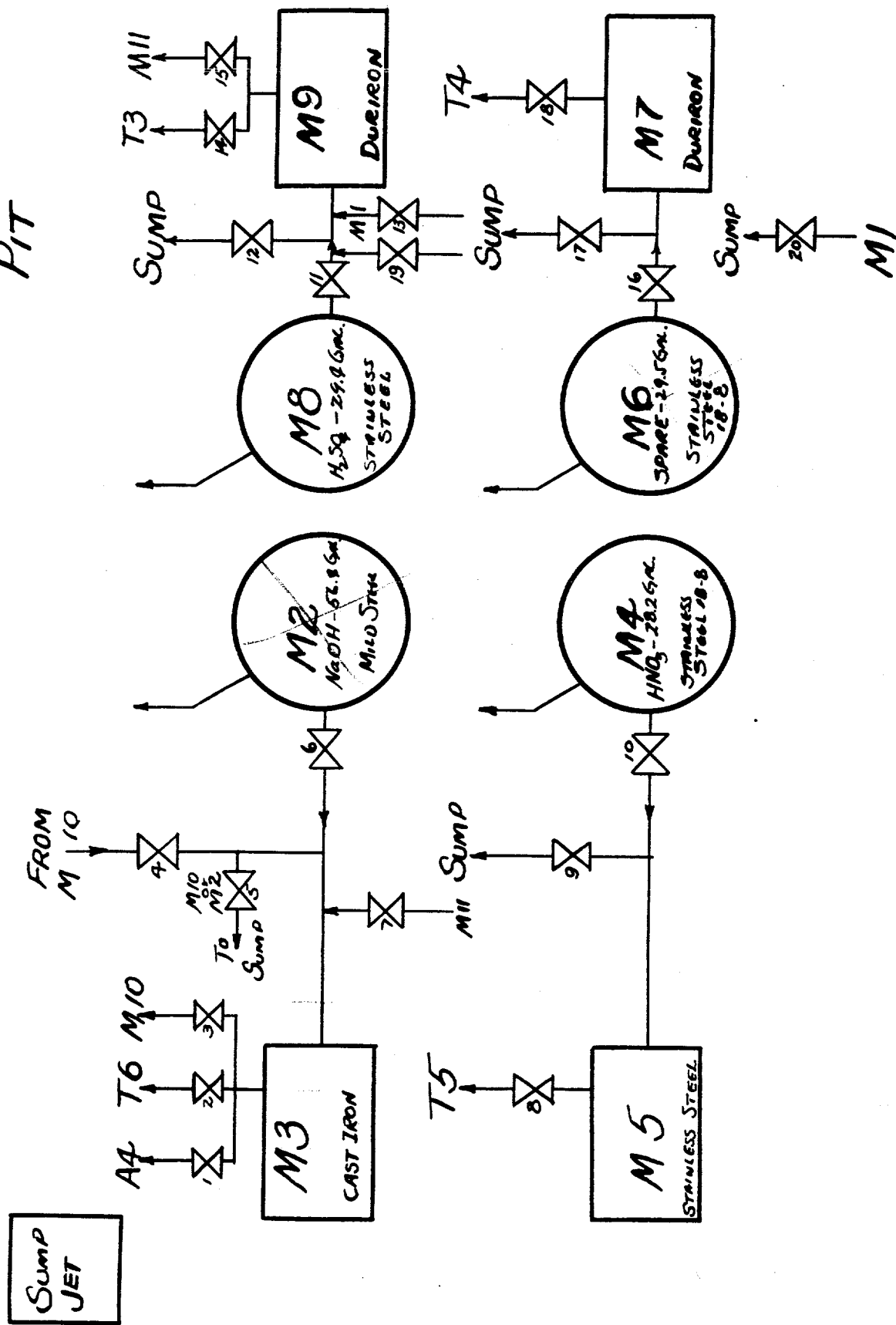
The following is a list of all solution make-up equipment. The "Starting Vessels" (1st column) are the tanks into which the process solutions are charged from carboys, drums or bags. The "Valve Open" (4th column) indicates the valves that must be open in order to transfer the solution to the "Receiving Vessel" (5th column), the temporary storage tanks prior to use in the process vessels. The "Drawing Number" (6th column) refers to the drawing which includes the equipment described in this table.

TABLE I

Starting Vessel	Solution	Transferred By	Valves Open	Receiving Vessel	Drawing Nos.
M2	NaOH	Pump M3 2HP, 1750 RPM 220 V, 3 ϕ	#6, #3 #6, #2 #6, #1	M10 (Make-up) T6 (Head Tank) A4 (Scrubber)	AE-1 and 2 AE-1 and 3 AE-4
M4	HNO ₃	Pump M5 2 HP, 1750 RPM, 220 V 3 ϕ	#10, #9 #10, #3	Sump T5 (Head Tank)	AE-1 AE-1 and 3
M9	H ₂ SO ₄	Pump M9 3HP, 1750 RPM, 440V, 3 ϕ	#11, #14 #11, #12	T5 (Head Tank) Sump	AE-1 and 3 AE-1
M6	Spare	Pump M7 3HP, 1750 RPM, 220V, 3 ϕ	#16, #17 #16, #18	Sump T4 (Head Tank)	AE-1 AE-1 and 3
M11	50% NaOH	Pump M3	#7, #1 #7, #2 #7, #3	A4 (Scrubber) T6 (Head Tank) M10 (Make-up)	AE-2 AE-2 and 3 AE-2
M10	4% NaOH	Pump M3	#1, #1 #1, #2 #4, #3	A4 T6 M10 (Circulating)	AE-2 AE-2 and 3 AE-2
M1	CO ₂ PO ₄	Jet (Steam) Drain	#21 #20	A5 (Neutralizer) Sump	AE-2 AE-2
Carboy or Drum	NaOH	Jet (Steam)	#22, #23	M10	AE-2

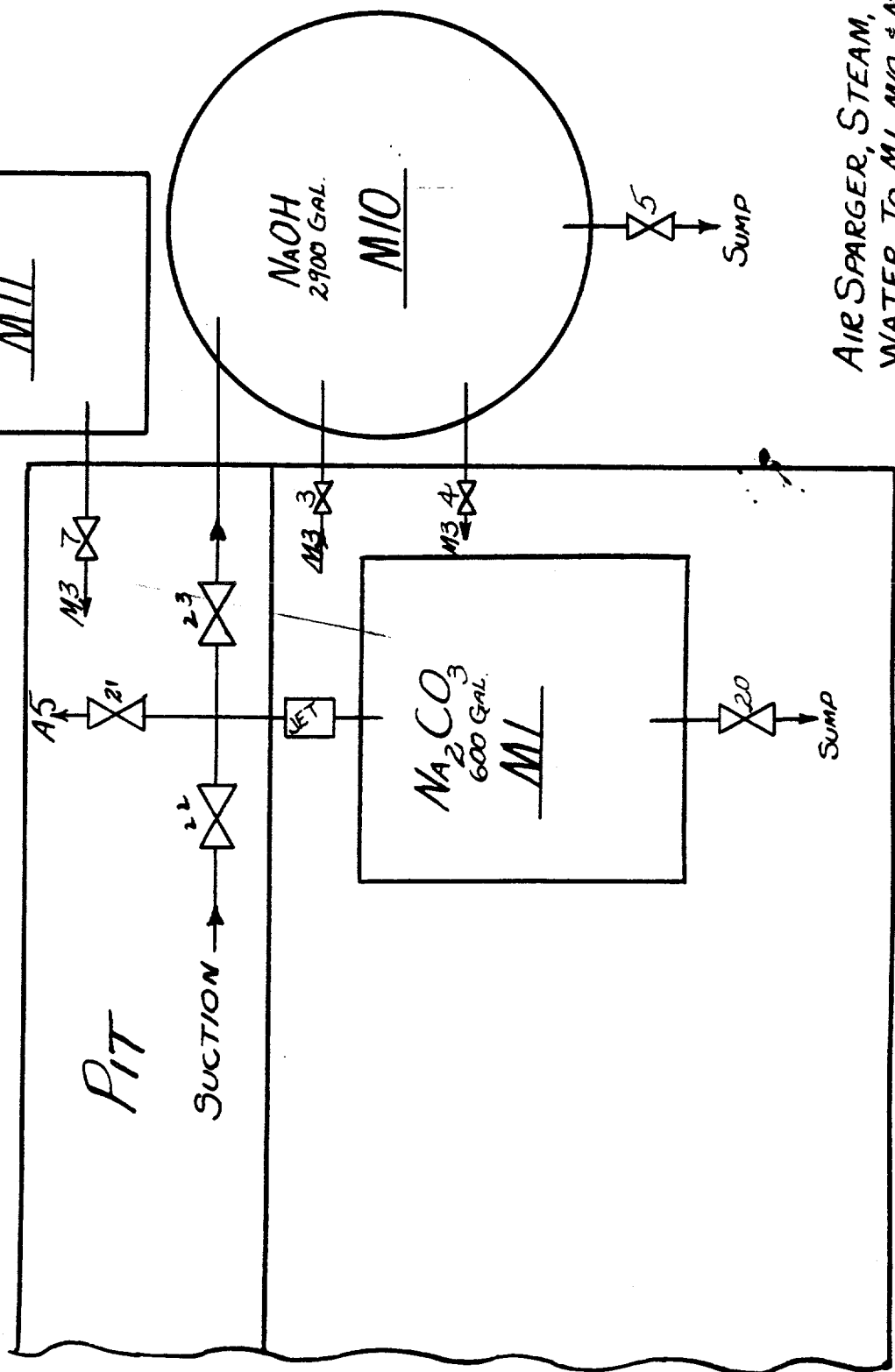
DRAWING NO. AE-1

FIRST FLOOR
RM. 10
PIT



DRAWING NO. AE-2

FIRST FLOOR
Rm. 10



AIR SPARGER, STEAM, &
WATER TO M1, M10, & M11.

T4
SPARE
50 GAL.

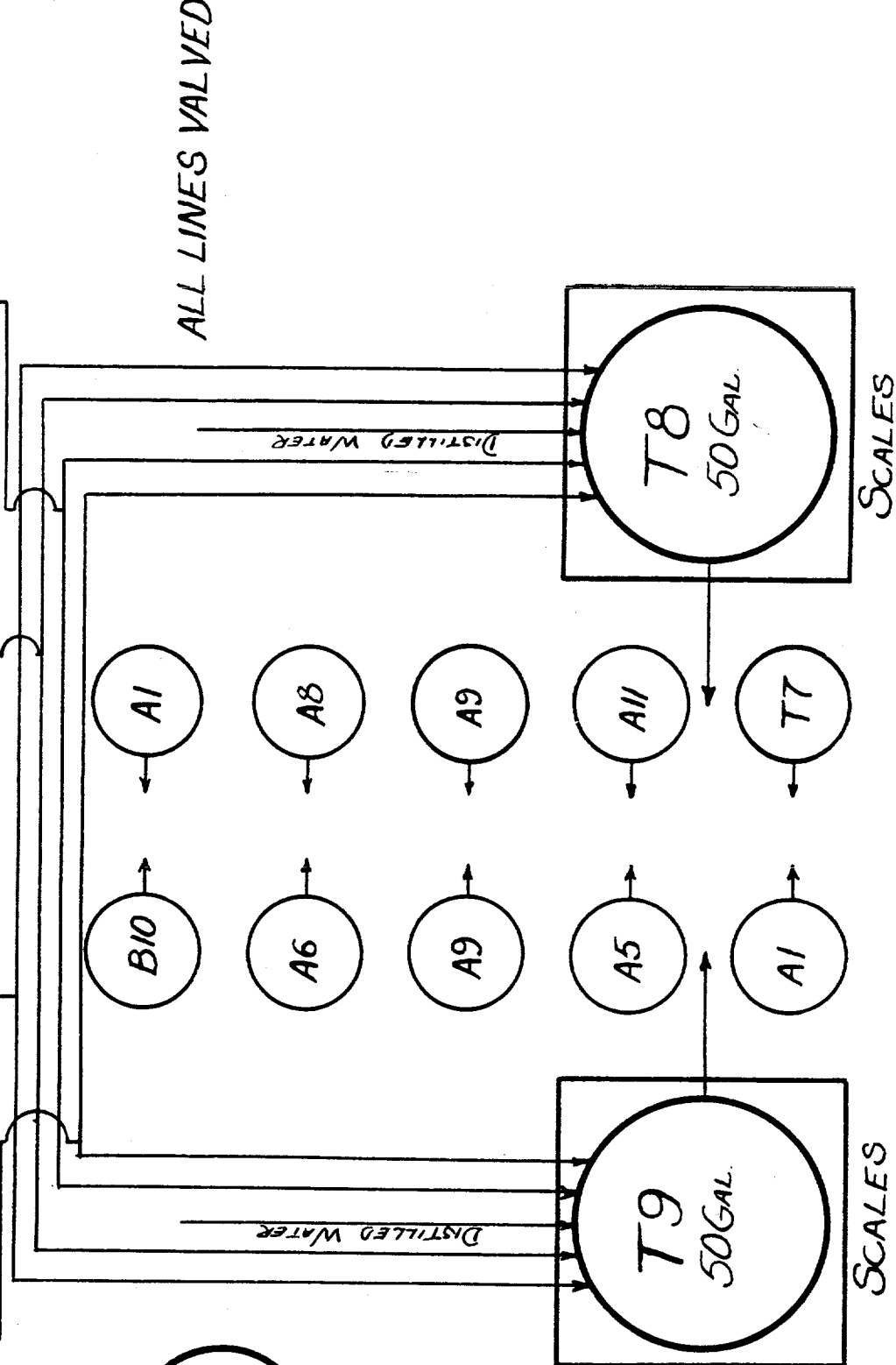
T3
 H_2SO_4
50 GAL.

T5
 HNO_3
50 GAL.

T6
 $NaOH$
50 GAL.

T2
 Na_2CO_3
10 GAL.

T1
 $Pb(NO_3)_2$
5 GAL.



3RD FLOOR SOLUTION
TANKS

DRAWING NO. AE-3

TABLE II

List of Make-up Equipment File PrintsA. Room 10 - First Floor - Drawing Numbers1. Details ED-234

- a. M1 - CL-706D-73
- b. M2 - CL-706D-74
- c. M4 - CL-706D-75
- d. M6 & M8 - CL-706D-76
- e. M-10 - CL-706D-63
- f. M-11 - D-12

2. Arrangement & Piping - CL-706D-1073. Pump Pit - CL-706D-1624. Exhaust System - CL-706D-1575. Measuring Rods - CL-706D-186B. Second Floor - Details T7 - CL-706D-79C. Third Floor1. Details ED-234

- a. T1 & T2 - CL-706D-61
- b. T3, T4, T6 - CL-706D-78
- T4 (Lead) - CL-706D-184
- c. T6 - CL-706D-64
- d. T8 & T9 - CL-706D-65

2. Head Tank Platform - CL-706D-1483. Piping - CL-706D-108D. Motor List1. Sulfuric Acid Pump - M9
3 HP, 1750 RPM, 440V, 3 phase, Gen. Elec.2. Spare Pump - M7
3 HP, 1750 RPM, 220V, " "3. Nitric Acid Pump - M5
2 HP, 1750 RPM, 220V, " "4. Caustic Pump - M3
2 HP, 1750 RPM, 220V, " "5. Exhaust Fan
3 HP, 1750 RPM, 440V, " "

SERVICES

General

The 706-D building is supplied with 440, 220 and 110 volts of alternating electrical current. This supply comes from the K-25 area and from the TVA project. In case of an electrical disruption in the outside service, this building has a gasoline driven generator to supply 110 volts for emergency lighting only.

The 125 psi steam is produced in the Clinton Laboratories Power House. This 125 psi source is reduced to 25 psi giving two pressures for the building's operations and heating.

Gas, air, and filtered water are taken from reservoirs on the area.

Distilled water, vacuum and ventilation are produced within the walls of the 706-D building.

Locations of Service Equipment

In case of certain conditions prevailing, various services must be cut off. The following list will give the locations of the main valves and switches:

Steam - 2nd floor, low storage area, behind the hot water tank over change room.

Electricity - Designated switches on Main Panel Board, 1st floor, at the base of stairs on the west side of the building. If these switches are not accessible, there is a master switch near the bank of transformers outside the building, on the west side.

Gas, Air, Water - Main valves are in wells just off the road bed between the east loading platform and the main entrance.

Ventilation - Electrical switch on Main Panel Board, 1st floor, controls the building air circulation. The ventilation fans for the hoods in the analytical laboratories are switched in the main hall at the entrance to the "Hot Labs."

Hoists - Two one-ton hoists are on short tracks over the lead barricades in each of the "Hot Labs." One three-ton hoist serves the 1st floor storage area over "Hot Labs." Another three-ton hoist is on third floor running the length of the building and serves as the lift from first floor to third.

Distilled Water - The stills are located in the crows nest on the third floor, west side of the building.

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SERVICES

Page 5

"Hot Drains" - Four drains located in the Analytical Laboratories empty into W-11.

Process Drains - All drains that are not marked "Hot" are process. These empty into the Settling Basin.

List of Prints of Building Services

Heat

Details - CL-706D-43
1st Floor - CL-706D-45
2nd Floor - CL-706D-46
3rd Floor - CL-706D-47

Lighting

1st Floor - CL-706D-38
2nd Floor - CL-706D-39
3rd Floor - CL-706D-40

Power

Details & Miscellaneous - CL-706D-41 & 132
1st Floor - CL-706D-37
2nd Floor - CL-706D-42
3rd Floor - CL-706D-43

Drains - CL-706D-124

Ventilation

Details - CL-706D-80
Hoods - CL-706D-142
Equipment -
Decontamination Room - CL-706D-270
Make-up Room - CL-706D-157

Steam and Air - CL-706D-11 & 19

Distilled Water - CL-706D-144

Service Piping

Details - CL-706D-52
2nd Floor - CL-706D-49
3rd Floor - CL-706D-50

Settling Basin

FIRE EQUIPMENT

Fire Hoses

1. First Floor, Northwest wall.
2. Under stairs to low storage area.

CO-2WD Extinguishers

1. First Floor
 - a. Large truck under stairs leading to supervisor's office.
 - b. Entrance from North loading platform.
 - c. Main entrance to "Hot Labs."
 - d. Entrance to main Analytical Lab. from Analytical office.
2. Second Floor
 - a. Top of stairs from main entrance to 2nd floor.
 - b. Entrance from operational area to supervisor's office.

Sodium Bicarbonate Extinguishers

First floor under stairs to low storage area over the change room.

SOS Fire Guard - (For oil and electric fires)

1. First Floor
 - a. Change room, entrance to washroom.
 - b. Entrance to "C" building from "D".
2. Second Floor

Entrance to low storage area.
3. Third Floor
 - a. To the right of battery chargers.
 - b. Building ventilation fans motor.

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DECONTAMINATION

DECONTAMINATION

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PERSONNEL DECONTAMINATION

General

To eliminate the possibility of contaminating personally owned clothing, the operating personnel is provided with a complete set of clean clothing at the beginning of each shift. This clothing is washed at the plant laundry.

To remove any possible body contamination, each person is required to take a shower before leaving the plant at the end of the shift.

Frequent checking for contamination of shoes and hands is recommended and it is required that hands and clothing be checked before eating, at the end of the shift, and after taking a sample or handling any hot material.

Decontamination of Hands

The plant tolerance for hand contamination is a reading of 100 (700 counts per minute) on the hand counter. The tolerance set by 706-D supervision is a reading of 40 on the hand counter.

To remove radioactive contamination from the hands, the surgical method of washing the hands with soap, water and a small brush is recommended. The process takes about 10 minutes and involves scrubbing each of the digits lightly but thoroughly with soap and water.

Oftentimes a quicker method which involves washing the hands in the usual manner with LanoKleen hand cleaner is effective.

Chemicals sometimes give the fastest results but are not recommended by the medical department because of their harmful effect on the skin. In extreme cases, TiO_2 paste or a solution of potassium permanganate followed by a solution of sodium bisulfite may be used.

Decontamination of Shoes

The Health Physics tolerance on shoes is 1000 counts per minute on the inside of the shoes and 10,000 counts per minute on the outside of the shoes. If the foot counter reading is greater than 30 (10,000 counts per minute), the shoes should be scrubbed down to a reading of less than 8 (2700 counts per minute).

Several methods are used to remove contamination from shoes. Using a brush for scrubbing with soap and water is often effective. A floor basin has been provided in the locker room for this purpose. Care must be taken to avoid contaminating the hands and of course excessive amounts of water will ruin the shoes. Another method is to place a handful of solid anhydrous sodium carbonate on the floor near a floor drain.

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PERSONNEL DECONTAMINATION

Page 2

A little water is added to form a paste and the soles of the contaminated shoes are rubbed on this. Water is used to wash the removed contamination down the drain. The simplest method is to scuff the bottom of the shoes in gravel which is often very effective in bring the contamination level down to below tolerance.

Emergency Decontamination

A special decontamination room located next to the wash room has been provided in case anyone gets badly contaminated. Badly contaminated clothing can be removed and placed in a special bin. A special shower has also been provided so as to confine the contamination to this one room. If a high count is noticed on the throat or chest after removing clothing and showering, the medical authorities are contacted.

S E C R E T

EQUIPMENT AND BUILDING CONTAMINATIONGeneral

Contamination usually exists in the form of a salt of some fission product which adheres to the surface of the material. Decontamination involves the removal of these salts by dissolution or by mechanical methods.

Since the composition of the contaminating material usually varies, it is impossible to set forth ironclad rules for the best methods and chemicals to be used in the decontamination of various materials. A general rule, however, is to try to remove the contaminating material without damaging the equipment. The following discussion, therefore, is offered only as suggestions based on past experience rather than as rules for decontamination.

Removal of radioactive contamination is required mainly to reduce radiation levels to such an extent that personnel can work for a short period of time without receiving an overexposure. In the cells, this means cleaning the walls, ceiling and floor as well as the process equipment itself.

Decontamination of Cell A

The bulk of the process equipment is constructed of stainless steel which is corrosion resistant toward nitric acid. In the past, this has been decontaminated by using alternate treatments of boiling 30% nitric acid and boiling 26% sodium carbonate. Several hundred pounds of 30% nitric acid are added to A1 and boiled there for approximately 30 minutes. It is then jetted to A9, running a part of the solution through each of the jet lines going from A1 to A9. During the process, solution is jetted also through any jet lines leading from A9 to A1. At the end of the step, however, all of the solution should be in A9. After boiling in A9, the solution is jetted to A8, making sure to run some of the solution through all jet lines interconnecting A9 and A8 in a manner similar to that described previously for jet lines between A1 and A9. In a like manner, the solution is transferred successively to A11, A6 and A5. While this is in progress, part of the decontaminating solution is circulated through the sample blisters in order to decontaminate sampling lines. Acid solutions are jetted into A5 which contains a calculated quantity of sodium carbonate for neutralizing the acid. From A5 the neutralized solution goes to W11 where it is disposed of as hot waste.

In a similar fashion, 26% sodium carbonate solution is run through the equipment. Since waste liquids sent to the tank farm must be either neutral or alkaline, sodium carbonate, being alkaline, can be transferred directly to the tank farm from A5.

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In extreme cases, a 5% fluosilicate solution in dilute HNO_3 has been used. However, the temperature of this solution must be kept below 60°C since this solution is very corrosive on stainless steel at higher temperatures. This solution is also neutralized with a calculated amount of sodium carbonate and sent to the tank farm where the radioactive wastes are disposed of in a safe manner.

Where radioactive contamination is present on the outside surfaces of stainless steel equipment, a method of spraying the outside surfaces with nitric acid followed by copious volumes of water has been used. Before this is done, however, generous quantities of solid sodium carbonate are scattered on the cell floor, which is covered with sheet lead, to neutralize the acid spray. The large volumes of liquid resulting from this procedure are eliminated by jetting from the sump to A6 and the tank farm in the usual manner. When activity levels have been reduced sufficiently, local hot spots are sometimes removed by scrubbing manually with a brush taking care to stay within time limits prescribed to avoid overexposure. Blowing live steam at an affected area by means of a flexible hose is often effective in removing a local hot spot.

Often times local hot spots are caused by gasketing material used between flanges. Experience has shown that these gaskets become impregnated with radioactive material which is impossible to remove with ordinary decontamination methods. In such cases, the only alternative is to remove the gasket itself which is usually costly with regard to exposure time due to the limited time any person can be in the vicinity of such a hot spot and still stay within exposure tolerances. In some cases, special pieces of lead shielding are placed around local hot spots to reduce the radiation level and allow necessary work to be done in the vicinity.

In decontaminating a cell, the A-16 off-gas system must also be taken into account. The portion of the A-16 system in the cells is isolated from the rest of the system by closing the valve in the line leading to the intake of the A-16 blower. When this is done, the operation of the blower is also discontinued. The A-16 scrubber drain valve is then closed and all valves in the A-16 line leading into the various process vessels are opened wide. There is a pipe connection to the top of the A-16 scrubber to which is connected a high pressure steam hose which allows the A-16 line to be steam chased back into the individual process vessels. This method has been quite satisfactory in decontaminating the A-16 off-gas system.

The cell ventilating system which keeps Cell A and Cell B under approximately $1''$ of water vacuum is also decontaminated on occasion. This is usually done, however, when the main blower can be shut down without excessive airborne contamination leaking into the building from the cells which are now under atmospheric pressure. Favorable wind conditions (i.e. from the southwest) are also sought for this operation. Permanent steam nozzles have been installed in the $36''$ duct and decontamination is accomplished by steaming as long as necessary.

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In decontaminating a cell it has usually been necessary to decontaminate the cell walls, floor, ceiling, exteriors of process equipment and piping and also accessory equipment such as vessel supports, lighting conduits, etc. Some of this has been touched on in the discussion previously, we shall now go into more detail.

The cell walls and ceiling are of concrete covered with acid proof paint (Ucilon) and the flooring is also concrete covered with sheet lead. Vessel supports are largely of ordinary steel construction while electrical conduits are now of stainless steel construction.

Even after the interiors of process equipment and piping have been decontaminated intensively, a relatively high radiation background exists in the cells due to escaped radioactive materials processed within the apparatus. However, the radiation level is now low enough so that sufficient time is available to install a specially built fire-hose stand in labyrinth composing the cell doorway. This hose can be aimed at almost any portion of the cell and its position is changed periodically in order to wash as much of the cell as possible. This method is successful in reducing radioactive levels considerably. The water collecting in the cell sump is jetted to W-11 as long as it contains much radioactivity. When the amount of radioactivity being taken up by the water becomes very small, a portable pump is moved into the cell passageway and the water is then pumped from the sump to a building floor drain which empties directly into the settling basin which in turn discharges into White Oak Creek in such a fashion that radioactivity tolerance levels set up for the creek are never exceeded. This allows the rate of hosing to be greatly increased and also removes a burden from that portion of the tank farm which treats wastes in order to make them safe for disposal into the creek.

In order to still further decontaminate the cell, the following is also done. A sand blasting machine is used to cover with a thin blanket of fine mesh sodium carbonate every exposed surface in the cell. With all the process vessels empty at this stage, all the steam jets and spargers are turned on to fill the cell with steam. Since this has to be done with the cell ventilation system not operating, it is used after all previous methods have been tried and the amounts of radioactive material to be removed are relatively small. If this method is tried early in the decontamination procedure, airborne radioactivity exceeds by many times the tolerance levels set up by management for health reasons. The cell is allowed to steam for a period of several hours after which it is hosed down with water which is disposed of in the manner described previously. This procedure, along with those earlier discussed, are repeatedly used until the radiation level in the cell is reduced sufficiently for one to remain in the cell for a short period of time per day.

Decontamination is a costly procedure because it is a time consuming operation involving use of considerable quantities of chemicals not to mention repair work often necessitated because of unavoidable damage done while in the process of decontamination.

Decontamination of Cell B

Generally speaking, Cell B is decontaminated in much the same way as Cell A. Hence, only a brief outline of the decontamination of the interiors of the process equipment will be presented here.

The larger sized process tanks are treated as follows. 30% nitric acid is added to A9 (Cell A) from which it is jetted to B1-B3-B6-B10 in succession with heating in each one of the vessels for a short period of time. From B10 the acid is jetted to A5 where it is neutralized and disposed of as described previously. Alternate cycles of nitric acid, sodium carbonate and fluosilicate are used as required. Cycles may vary from 50 to 100 lbs.

One liter of decontaminating solution (nitric, carbonate, etc.) is added to B7 rest well, sucked into B7 movable pipette and directed into B17 through a funnel on the golden horseshoe. Another liter of solution is added to B8 rest well, sucked into B8 movable pipette and directed to B17 through a funnel on the golden horseshoe. It is sucked out of B17 with B7 pipette and added to vessel B26 through another funnel in the golden horseshoe. From B26 it is sucked into vessel B27 going through the sintered glass filter disc located in lead Cell IV. From B27 it is forced to B12 with air pressure. Either B7 or B8 is used to move the liquid from B12 to the upper discharge funnel from where it flows into the movable funnel rack where it is directed to B19.

Stationary pipettes B2, B9, B11 are decontaminated with steam. A special piping arrangement has been provided behind panelboard 48 for this purpose.

Decontamination of the exteriors of the vessels, accessory equipment and the cell in general has been discussed previously.

It must be kept in mind that other materials besides those mentioned can be used for decontamination. Some of these tried have been oxalates, citrates, soap, HCl, H_2SO_4 ; the only criterion being that more good than harm be done, ie, that one does not dissolve or corrode badly whatever is being decontaminated.

Decontamination of Lead Cubicles

This has been discussed in another portion of the manual so no further mention of it will be made here.

Miscellaneous Decontamination

During intensive operations, quite frequently the building floors will become badly contaminated from microscopic amounts of radioactive materials inadvertently gotten on the floor. If this condition is not discovered immediately, it will spread rapidly throughout the building on the shoes of personnel. Someone carrying above tolerance amounts of radioactivity on his hands will literally contaminate everything he touches.

Such a condition is bad from a health standpoint and after its discovery immediate corrective measures are undertaken. The first thing that is done is to determine the extent of the contamination and isolate the parts affected by posting signs. This is done to avoid further spread of the contaminating materials.

The choice of decontamination method depends on the type of surface which is contaminated. If on a concrete floor (most common condition of building contamination) the area affected is attacked with soap and water using a mop and/or brush. This is the preferred method since it is usually effective in removing contamination without damaging the paint job on the floor. Occasionally, stronger decontaminating agents have to be used but this is discouraged except as a last resort since this damages the paint which leaves the concrete open to attack by the acid. The action of acid leaves the concrete porous and when a porous surface gets contaminated, the contamination has to be removed by removing the surface to the depth affected. This is costly both from a standpoint of removing the old floor and also installing a new one.

If a wood surface has a good coating of paint (acid resistant preferably) any contamination can be removed with soap and water or other mild chemicals. Once the radioactive material has penetrated into the wood, the only course of action is to replace the wood.

Lead surfaces can usually be decontaminated by scrubbing with soap and water though dilute acid is very effective in extreme cases. This again is a last resort because it dissolves the surface of the metal.

Steel equipment is decontaminated by first trying soap, water and scrubbing then using increasingly stronger chemical agents until decontamination is effected (i.e., Na_2CO_3 , NaOH , HNO_3 , HCl , H_2SO_4 , etc.). As sometimes happens, nothing seems able to remove contamination. In such instances, the part affected is removed and set aside in an isolated area until the radioactive materials can decay to safe levels. When even this latter method is ineffective or undesirable, the part contaminated is simply buried for all time in a special burial ground provided for disposing of radioactive materials.

For decontamination of small portable pieces of equipment, two stainless steel drums have been set up in the decontamination room. The decontamination room is a special room with a acid proof brick forming the floor and also the walls to a height of four feet. This room is separately ventilated by a shower which exhausts the air of the decontamination room through the roof of 706-D.

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The stainless steel drums have a drain line to the sewer and also have permanently installed air, water and steam lines into them. Small articles, as hot glassware, hot tools, product cones, in fact anything not too large for the drums are placed therein. Decontamination is accomplished by filling drum with whatever agent is to be used for decontamination. The air or steam sparger are used at one's discretion and the decontaminating solution can be changed easily by means of the drain valve mentioned previously. The solution used for decontamination depends upon the chemical properties of the article to be decontaminated. Agents such as carbonates, phosphates, citrate, oxalates, etc., which are known to form complexes with some fission products are tried first though it is usually difficult to predict just how successful any decontaminating agent will be prior to its use.

Disposal of Hot Articles

As mentioned previously, sometimes hot articles have to be disposed of by removal to the burial ground. The discussion which follows holds true for anything of a radioactive nature which has to be disposed of whether it be a piece of equipment which cannot be decontaminated or whether it be trash contaminated with radioactive material as a result of processing going on in the area. Specially painted bright red trash cans with the word "HOT" painted in white on the lid are used to collect radioactively contaminated trash. Before anything is put into these cans they are usually lined with a special type of absorbent paper widely used in the area. Maintenance empties these cans on a regular schedule except in special cases. If a can reads more than 100 mr/hr at 1 foot but less than 500 mr/hr at 1 foot, maintenance is called on an emergency order to empty the trash cans immediately. Hot cans which read over 500 mr/hr at 1 foot are also disposed of on an emergency order, only in this case a representative of Health Physics goes along with maintenance to the burial ground to insure that the radioactive material is disposed of in a safe manner. Contaminated objects too large for the trash can or of an awkward shape are disposed of to the burial grounds in wooden crates made for that purpose.

SPECIAL TECHNIQUES

SPECIAL TECHNIQUES

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SPECIAL TECHNIQUES

Slug Handling

Slugs are loaded into a special carrier holding 26 slugs (see drawings GL-706D-211, 212 & 213) under 9 feet of water in the canal of the 105 area. This operation is done with a special pair of tongs approximately 10 feet in length. The diameters of the slugs are checked before loading into the carrier to insure none being oversize and thereby sticking in the carrier. When the carrier has been filled with radioactive slugs from the pile, the cover of the carrier is replaced, still under 9 feet of water, and the carrier is then hoisted out of the canal. A survey of the carrier for radiation is made by 105 supervision and the carrier loaded on a truck for delivery to 706-D.

The carrier is so designed that slugs are discharged individually when the carrier is being emptied. The carrier is positioned on the roof of Cell A over the loading chute to the dissolver and the carrier is emptied by operators performing the slug dropping from a distance of 10-12 feet. (See drawings mentioned before). A contact microphone installed on the dissolver in the cell tells one when a slug has reached the dissolver. The unloading of the carrier is done slowly enough so that slug has reached the dissolver before the next one is dropped. This is done to eliminate any chance of the loading tube becoming jammed with hot slugs which would create a serious radiation hazard. When the carrier appears empty, it is checked with a "Cutie Pie" before the carrier is prepared for return to the 105 area.

If any slug has stuck in the carrier it will be discovered at this point by the excessive radiation present. When a jammed slug is discovered in the carrier, special measures need to be taken either at 706-D or the 105 canal to correct the situation, preferably at the 105 canal area. However, if during the unloading, a slug has dropped a part of the way out of the carrier and then jammed, only one course of action is possible. That is to remove the top of the carrier and to force the jammed slug out of the carrier manually. A $\frac{1}{4}$ " to $\frac{3}{8}$ " steel rod, approximately 6' long, bent at right angles about a foot from one end plus a mirror arrangement enables one to do the job with a minimum of exposure. Under certain circumstances, one uses a straight rod and no mirrors but the allowable time using the latter method is considerably shorter.

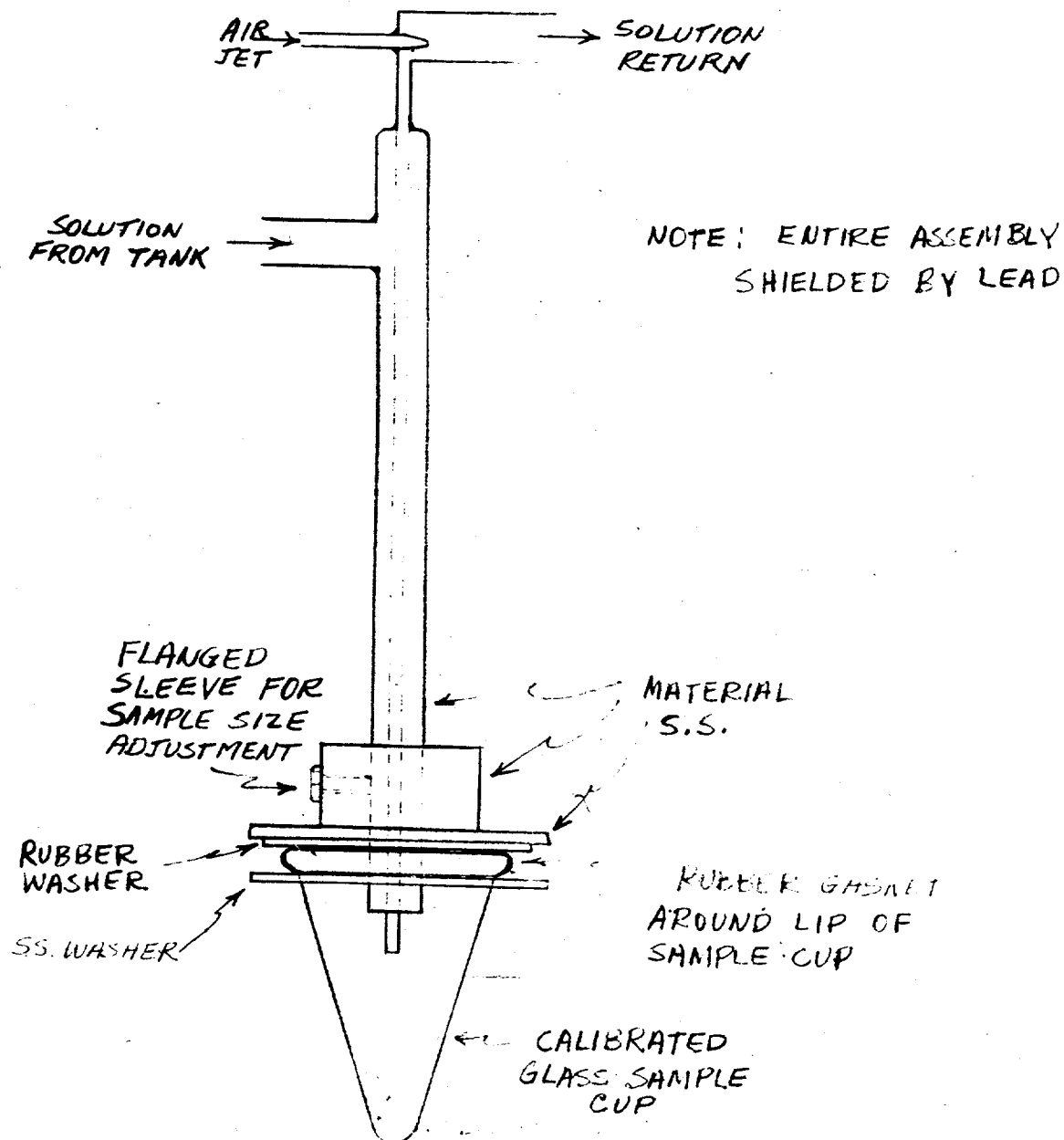
Sampling

Blister Sampler (See Drawing #ST-1)

The sampler consists of an air jet designed to circulate solution from the tank to be sampled through a glass sample cup and back to the tank. The entire assembly is surrounded by lead to reduce the radiation hazard. Details of the sampler are shown in Drawing No. GAP CL-706D-179E.

Equipment required for obtaining a sample consists of the sample cup and stainless steel washer as shown in the sketch, tongs and clip for inserting the sample cup, a lead carrier and carrier stand, rubber gloves and Kraft absorbent paper for covering the floor around the sampling area. The labeled glass sample cup, with a rubber gasket around the lip, is placed in the stainless steel washer. The washer and cup are placed on the long prongs of the clip and secured with the short prongs. The air jet is turned on, the blister door opened and the clip holding the sample, cup and washer, inserted into the blister. The short prongs on the upper face of the washer are released by compressing the spring on clip with the handle of the sample tongs. With the use of the tongs, the sample cup is moved in under the air jet assembly and is drawn into place by the suction from the jet. With the jet system closed, solution starts to circulate from the tank through the sample cup and back to the tank. The upper prongs of the clip, having been previously released, are withdrawn only sufficiently so they may be reinserted on top of the flange of the adjustable sleeve, while the lower, long prongs of the clip remain at all times underneath the stainless steel washer. This, in case of a break in vacuum due to failure of the air jet, the sample cup would be held in place between the lower prongs under the stainless steel washer and the upper prongs on top of the sleeve flange. The sample tongs are removed from the clip and the blister door closed. The solution is allowed to circulate for a minimum of fifteen minutes.

To remove the sample, the air jet is left on and the sample tongs are reinserted into the clip. By compressing the spring on the clip with the tongs, the short, upper prongs are released from the sleeve flange. Suction from the air jet will hold the glass sample cup in place even though the clip is released. Hence, it is necessary to pry the glass cup from the flange, using the short, upper prongs of the clip. Once the rubber to rubber connection between the glass sample cup and the sleeve flange is broken, the glass cup will fall down into the stainless steel washer which is held in place directly underneath the glass cup by the lower prongs of the clip. When the glass cup containing the solution sample has been forced from the sleeve flange and is resting in the washer, the upper prongs of the clip are clamped on top of the washer to prevent the sample cup from sliding off the lower prongs. The sample is removed from the blister and placed in the lead carrier. By compressing the spring on the clip with the tongs, the upper prongs of the clip are released from the washer. The clip and tongs are removed, leaving the sample and stainless steel washer in the carrier. The sample carrier with the sample is surveyed by a Health Physicist and is then taken to the south hot-laboratory. A sample sheet showing date, volume of solution, sample code number, etc., is turned over to a chemist who analyzes the sample.



DRAWING ST-1

BUSTER SAMPLER

CAPACITY - 5 CC

706-D

Following is the list of volumes required for various samples:

<u>Sample</u>	<u>Volume</u>	<u>Sample</u>	<u>Volume</u>
IMA	0.6 cc	GP	0.6 cc
SWMA	1.2	SWFN	0.6
GWMA	1.2	SWFb	0.6
SWW	.6	B6 Rinse	0.6
SCW	.6		

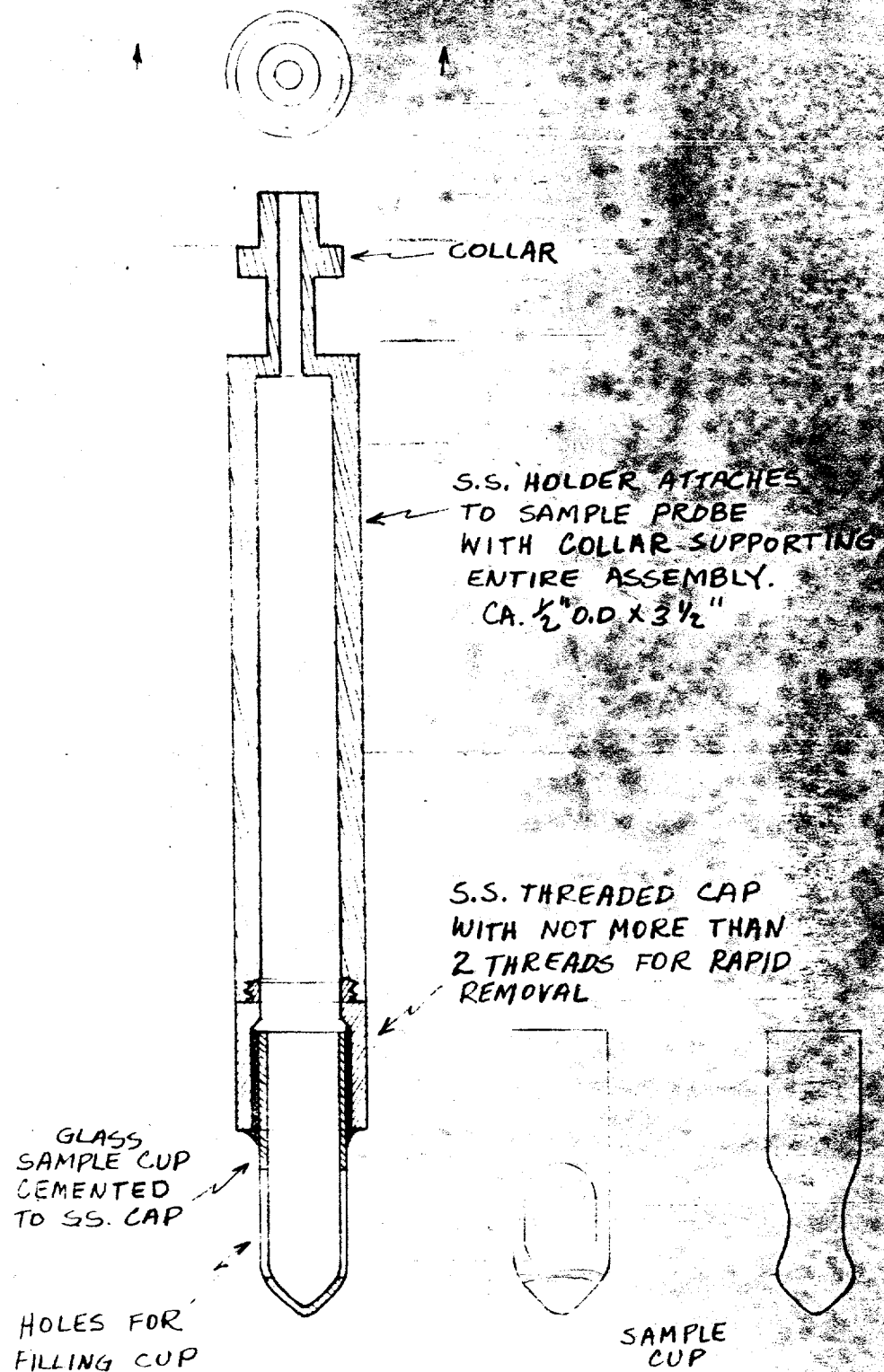
Most samples require 0.6 cc for analysis. Very hot samples obtained from Cell B, particularly the GP sample, should contain not more than 0.6 cc of solution because of the radiation hazard. It is important that the extraction waste samples, 8 WMA and GWMA, be greater than 1.0 cc in volume because the chemists require at least 1.0 cc of solution for an accurate analysis.

Dip Samples (See Drawing #ST-2)

Dip samples are taken on very highly radioactive solutions and contain only 0.1 to 0.2 cc of solution. At present, the 17P and 17T HCl samples are the only two taken by the dip method. However, if necessary, other hot solutions in Cell B can be sampled by the dip method via the liquid level probes. Dip samplers can be of either the bucket or the capillary type, though the bucket type is favored in current operations. The names are self explanatory, however, reference to drawings will give further information regarding the samplers.

Because of the high levels of radiation encountered, a Health Physics representative should be present during the sampling operation. To localize any spills or escape of radioactive material, absorbent "Kimpak" paper is spread on the floor in the immediate vicinity of the B17 probe. An empty "hot" trash can lined with "Kimpak" is located conveniently for disposal of any contamination.

In order to take a sample, the electric current to the probes and indicator light is switched off and the probe is raised so that its lower end is opposite the small door in the lead shielding around the probe (This latter is usually done with the door in the open position so that the end of the probe can be seen coming into view). A piece of cardboard or stiff paper is then laid over the top of the hole through which the probe enters the cell in order to prevent any extraneous matter from dropping into the cell and possibly into the vessel from which a sample is to be drawn. The assembled dip type sampler is then attached to the end of the probe using a long pair of laboratory forceps. The electric current is switched back on and the probe carefully lowered back into the cell until a panelboard light flashes ON indicating the probe has reached the liquid level. Before lowering the probe into the cell, it is carefully noted how much below the point where the light flashes on, the probe has to be lowered in order for the sample to be obtained. The probe is lowered the additional distance very carefully at which point the sampler fills with solution from the vessel.



DRAWING GT-2

DIP SAMPLER
CAPACITY-0.1 TO 0.2 CC
706-D

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Since the samplers of either type (bucket or capillary) are usually of glass construction, care must be taken not to lower the probe too far since this would crush the glass sampler against the bottom of the vessel. Also lowering the probe too far would put an undue amount of contamination on the outside of the sampler and on the probe itself.

The electric current to the probe is now switched OFF and the probe raised out of the cell again. If the capillary type sample is used, this has to be done very carefully to prevent the loss of the minute amount of sample. However, with either type of sampler any slight jarring or jerking may cause the sample to be lost. When the sampler comes into view, the piece of cardboard or stiff paper is replaced over the hole where the probe enters the cell and the dip type sampler is removed with a long pair of laboratory forceps. The sampler is placed in a 15 ml conical centrifuge tube contained in a lead sample carrier. During the removal of the sampler from the probe it is wise to wear heavy laboratory type rubber gloves which provide a shield for the high concentration of soft beta radiation associated with the sample. Rubber gloves will also help keep one from receiving a possible hand contamination during the removal of the sample.

A Health Physics representative makes a survey of the sample for radiation after which the sample along with a sample sheet giving pertinent information is delivered to the laboratory for analysis.

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Neutralization

The neutralization process which was described in other sections of this manual requires certain precautions which are worth reviewing.

One of the greatest sources of trouble experienced in this process was the contamination of Cell A and the off-gas duct due to the loss of vacuum in the neutralizer A5, during neutralization of metal wastes. This was caused by the operator's inability to determine whether A5 was under vacuum or pressure during neutralization since A5 is not a closed vessel and the resulting readings on the A5 pressure-vacuum manometer is always negligible.

Since the A5 off-gas line is manifolded with the A1 off-gas line to the 205 stack, it is not possible to open the A5 off-gas valve completely to obtain maximum vacuum during neutralization while slugs are being dissolved in A1, without creating a pressure in A1. To obtain adequate vacuum in both vessels while a dissolving and a neutralization is carried out, the A5 vent valve must be so regulated that the vacuum in A1 is kept at approximately 4" throughout the neutralization. The rate of gas evolution must be kept low by jetting the metal waste into A5 with a small (CL #2) jet, A11-A5 DB or A8-A5. The large (CL #1) jet A11-A5A is to be used only in an emergency.

The metal waste must always be jetted into the carbophosphate solution. The reverse procedure, which used only in emergency cases, results in excessive foaming of a precipitate which will not dissolve when agitated and can conceivably plug up the jet to W-9, the waste storage tank.

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Jetting and Decanting

During the first several runs, a great deal of difficulty was caused by inefficient methods of jet operation and improper design of transfer lines which resulted in building air contamination and back-up of activity from the cell to the operating area.

These difficulties have been entirely eliminated by redesigning some of the transfer lines and by developing techniques in jet operation which have led to setting up the following standard practices for jet operation and installation:

(1) CL #3 jets have been proven to be too small, too slow, and in general, impractical in our process. New jets of this type should never be installed as process equipment.

(2) To prevent activity from backing up through steam lines to the panel boards, the manifolding of jet discharge lines must be avoided unless it is absolutely impossible to do so and it is reasonably certain that the manifold is so designed that no solution can back up.

(3) CL #1 jets must be operated at approximately 60# pressure while the CL #2 and #3 jets must be at full pressure (90-120#) for maximum efficiency.

(4) The temperature of the solution should be 40°C or below before transfer is started.

(5) The jetting procedure for complete transfers follows:

- a) Open jet vent valve.
- b) Turn on steam slowly, blow down header for several seconds to remove loose corrosion in steam pipe.
- c) Close vent valve slowly. As the gauge pressure increased, adjust steam to desired pressure.
- d) When the manometer or Ring Balance indicates that transfer is complete, permit the jet to operate for about 15 more seconds before turning off the steam to the jet to transfer out a heel that may not be recorded on the manometer or Ring Balance.
- e) After the pressure has dropped to zero, open the vent valve. Keep the valve open for 30 seconds and then close it. Opening the vent valve before the pressure falls to zero will

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cause contamination to rush out through the vent with the steam. Complete elimination of venting may result in the formation of a vacuum in the steam line and consequent back-up of activity into the operating area.

(6) The process of decantation is essentially the same as that of complete transfer with these modifications and additions.

- a) The liquid level bubblers which are kept on at a slow rate during settling must remain at the same rate during decantation.
- b) The vacuum on the vessel from which the material is decanted, must be maintained at approximately 1" to prevent agitation of the precipitate by fluctuation of the vacuum.
- c) The steam to the jet must be turned off when the liquid level is slightly higher than the desired level. This must be done with accuracy when the desired level is low.

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INSTRUMENTATION

INSTRUMENTATION

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INSTRUMENTATION

Electronic Instruments

General

Various electronic instruments have been installed throughout the working area for the purpose of measuring radiation levels at selected spots. The instruments have been strategically placed so as to give the individual an overall picture of the radiation levels of the building. The types of instruments with brief descriptions are listed below.

Integrators

The integrator measures cumulative radiation with full scale deflection of the instrument set at 100 mr/hr. The instrument is recharged either with the cumulation of 100 mr, or with the passing of an 8-hour time interval which ever occurs first. Micromax recorders for the various integrators are located on Panel Board #7 at the north end of the 3rd level. Under the assumption of 100 mr/8 hr as a tolerance dosage, tolerance slopes are drawn on each of the recorders. The building is equipped with five integrators located in the following positions:

- 1) Panel Board #1 (2nd level east side Cell A)
- 2) West Side Cell B (2nd level)
- 3) North end of 3rd level.
- 4) South end of 3rd level.
- 5) Southwest Corner Cell A (1st level)

Monitors

The monitors differ from the integrators in that they measure radiation levels directly. The instrument is equipped with two scales reading from 0-25 mr and 25-125 mr respectively. The buzzer type alarm denotes a higher reading than 12.5 mr/hr which is plant tolerance based on an 8 hour day.

Micromax recorders for the various monitors are located on Panel Board #7 at the north end of 3rd level. The instruments are located at the following positions.

- 1) West Side Cell B (2nd level)
- 2) East Side Cell B (2nd level)
- 3) Passageway to Cell A.

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- 4) Passageway to Cell B.
- 5) Equipment Decontamination - Room #15.
- 6) North Hot Laboratory.
- 7) South Hot Laboratory.

Octopus

Low range instruments, commonly known as friskers, for the purpose of detecting radioactive particles on personnel are located in the Wash Room and Monitoring Room. Each person, upon the completion of a work period, is required to walk through the nest of friskers in Wash Room for the purpose stated above, and if any activity is found to be present, the clothing is disposed of in Room 8. Radiation as low as 2 mr at the wire guard on the friskers can be detected and is indicated by the ringing of bells.

Periscopes

Many steps in the process require very close visual observation in order to successfully carry out a run to completion. Due to the tremendous amount of shielding that is required in this type of work it becomes imperative to resort to the use of periscopes as a means of fulfilling the above requirement. This is especially true of the operations in Cell B due to the tremendously reduced volume of the charge and the very intricate equipment involved.

Two types of scopes are now being utilized, namely; the specific viewer and the overall viewer. The latter has the distinct advantage of a larger area of vision due to a larger mirror electrically operated to produce an angle of vision of approximately 180°.

Listed below are the various viewers giving their locations, process equipment to view, and the direction of the viewing station.

Specific Viewers

<u>Location</u>	<u>Process Equipment to View</u>	<u>Direction</u>
BN A4	B12, B17	Horizontal
BN B1	Funnel Rack	Horizontal
BN G2	Cone in Carrier	Vertically Down
BN J2	B19 Assembly	Vertically Down
BN 1st Level	Glassware (Cells 1, 2, 3, & 4)	Vertically Down

Overall Viewers

Due to the large angle of vision, the entire equipment in Cells A & B can be viewed from one or more of the four overall viewers located at the following places:

- 1) AW (2nd level)
- 2) BW (2nd level)
- 3) BW (2nd level)
- 4) BW (1st level)

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Inter-Communication System

As a medium of communicating with personnel in various parts of the building an inter-communication system is used with receiving and transmitting boxes located at the positions shown below. Each member of the department is assigned a code ring.

- 1) Solution Make-up Room #16
- 2) Panel Boards (1, 2, 4A and Cubicle)
- 3) Offices #12, 21, 22, 23, 25, 26, 31 and 32)
- 4) Wash Room #8

Maintenance and upkeep of the intercoms are the responsibility of the Instrument Department.

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Industrial Instruments

As in any chemical operating plant, many of the more common types of instruments are necessary for controlling various conditions throughout the process. Although some of these instruments are only indicating, many of them are indicating and recording. In general, manometers are used for indicating liquid levels, specific gravities and pressure differentials; however, recording ring balances are employed in some of the steps where the success of the operation is dependent upon the maintenance of the proper levels, gravities and pressures. Recording micromaxes are in general used for measuring temperatures.

The description, use and number of the various instruments are listed below according to the panel board on which they are located and the number of the instrument on the board.

Panel Board #1

- 1) Ring balance. Liquid level and specific gravity for Tank A1. Reads 0"-48" of water liquid level and specific gravity of 1.0-2.5.
- 2) L & H model "S" Micromax temperature recorder. 0°-150°C I.C. couples. Selector Switch for following temperatures:
 - a. Tank A1
 - b. Pipe A2 to A3
 - c. A2 exit cooling H₂O
 - d. Tank A5
 - e. Pipe A4 to W11
- 3) Taylor Dial Thermometer for Cell A temperature. Stem well installed in Cell A intake duct just before it enters Labyrinth. 0°-110°F.
- 4) 4" Model GP-6 single tube draft gauge for Cell A. Reads 0"-4" H₂O using meriam red oil. Specific gravity - 0.827.
- 5) Ring Balance Recorder for A1 to Cell pressure. Reads $\pm 10"$ H₂O.
- 6) 12" Model A-275 FF Meriam raised well manometer measuring pressure between A2 and Cell A. Reads $\pm 18"$ H₂O using Meriam #3 fluid.
- 7) 16" Model A-275 FF Meriam raised well manometer. Measures pressure differential across A4. Reads $\pm 24"$ H₂O using Meriam #3 fluid.
- 8) Schutte & Koerting Universal Rotometer, size 6. Measuring flow from L3 to A4.
- 9) 12" Model A-275 Meriam raised well manometer measuring pressure difference between A5 and Cell A. Reads $\pm 18"$ H₂O using #3 fluid.

- 10) Victoreen Integron for measuring radiation at center of panel board. Range - 0 - 100 mr.
- 11) Ring Balance. Liquid level and specific gravity for tank A5. Reads 0"-72" H₂O liquid level and specific gravity of 1.0-2.5.
- 12) L & N Model "S" Micromax Temperature Indicator. 12 point selector switch with temperature range 0°-150°C I.C. couples. Records following temperatures:
 - a. Pipe A1 jacket discharge
 - b. Gas pipe A3 to A4
 - c. Gas pipe A4 to 205 stack
 - d. Pipe M1 to A5
 - e. Jet A5-A5A
 - f. Jet A5-A5B
 - g. A1 solution
- 13) Ring Balance. Liquid level and specific gravity of tank A6. 0"-84" H₂O liquid level and 1.0-2.5 specific gravity.
- 14) 12" Model A-275 FF Meriam raised well manometer measuring pressure between A6 and Cell A. Reads \pm 18" H₂O using #3 fluid.
- 15) L & N Model "S" Micromax Temperature Indicator with 12 point selector switch measuring temperatures 0°-150°C I.C. couples. Measures following temperatures:
 - a. Tank A6
 - b. Jet A6-A6
 - c. Jet A8-A8DA

Panel Board #2

- 1) Loud speaker for contact mike. A1 slug chute and A9 agitator.
- 2) Slug counter (Production Instrument Co.).
- 3) Esterline -Angus Recorder. Used to record number of slugs dropped to A1.
- 4) 12" Model A-275 FF Meriam raised well manometer measuring pressure between A11 & Cell A. Reads \pm 18" H₂O using Meriam #3 fluid.
- 5) Meriam Model A-953 inclined manometer. Specific gravity for Tank A11. Reads 4"-8" of H₂O.
- 6) Meriam Model A-275 FF 12" Standard Well Manometer. Liquid level for tank A11. Reads 0-165" H₂O using mercury.

- 7) L & N Model "S" Micromax Temperature Indicator. 12 Point Selector Switch 0°-100°C I.C. couples. It is used to measure the following temperatures:
 - a. Temperature tank A8
 - b. Jet A8-A8
 - c. Temperature tank A9
 - d. Temperature tank A9
 - e. Jet A9-A8DA
 - f. Jet A9-A8DB
 - g. Temperature tank A-11
- 8) Meriam Model A-275 FF 12" Standard Well Manometer liquid level for tank A8. Reads 0-165" of H₂O using mercury.
- 9) Meriam Model A-953 inclined Manometer. Special gravity for tank A8. Reads 4"-8" H₂O.
- 10) Meriam Model A-275 FF 12" raised well manometer. Measures pressure between A8 and Cell A. Reads \pm 18" H₂O using Meriam #3 fluid.
- 11) A9 Agitator Ammeter. 0-2.5 amps.
- 12) A9 Agitator Control Switch. Allen-Bradley type 2 HA.
- 13) Meriam Model A-275 FF 12" raised well manometer. Measures pressure between A9 and Cell A. Reads \pm 18" H₂O using Meriam #3 fluid.
- 14) Meriam Model A-275 FF 12" Manometer - Standard Well. No. 1 liquid level for tank A9. Reads 0"-165" of H₂O using mercury.
- 15) Meriam Model A-275 W.H. 24" Manometer. No. 2 liquid level for tank A9. Reads 0"-24" of H₂O using Meriam #1 fluid.
- 16) Meriam Model A-953 inclined Manometer. Specific gravity for tank A9. Reads 4"-8" of H₂O.
- 17) L & N Model "S" Micromax Temperature Indicator. 12 point selector switch. 0°-150°C I.C. couples. Measures following temperatures:
 - a. Jet A9-B1A
 - b. Jet A9-B1DD
 - c. Gas pipe A10-A16
 - d. Pipe A16-706D
- 18) Meriam Model A-275 FF 6" Standard Well Manometer. Pressure between top of tank A16 and Cell A. Reads 0"-80" H₂O using mercury.

- 19) Meriam Model A-275 FF 6" Standard Well Manometer. Pressure between bottom of tank A16 and Cell A. Reads 0-80" of H₂O using mercury.
- 20) Schutte & Koerting Universal Rotometer, size 8. For flow of H₂O to A16 scrubber.

Panel Board #5

- 1) Meriam Model A-275 FF 12" Standard Well Manometer. B-sump liquid level. Use Meriam #3 fluid.
- 2) Meriam Model A-275 FF 12" Standard Well Manometer. B-sump density. Use Meriam oil - specific gravity 0.827.
- 3) Meriam Model A-275 FF 12" Standard Well Manometer. B-sump liquid level. Use Meriam #3 fluid.
- 4) Meriam Model A-275 FF 12" Standard Well Manometer. A-sump density. Use Meriam oil - specific gravity - 0.827.

Panel Board #4A

- 1) Meriam Model A-953 inclined Monometer. Specific gravity of tank B1. Reads 4"-8" H₂O.
- 2) 2" Model GP4 Meriam single tube draft gauge for air flow to tank B1 sparger. Reads 0"-2" of H₂O using red oil, specific gravity 0.827.
- 3) Meriam Model A-275 W.M. 24" Standard Well Manometer. Liquid level tank B1. Read 0-72" H₂O using Meriam #3 fluid.
- 4) Meriam Model A-275 FF 12" Raised Well Manometer. Pressure differential B1 to Cell B. Read \pm 18" H₂O using Meriam #3 fluid.
- 5) L & N Model "R" Micromax Temperature Indicator. 12 point selector switch for following temperatures:
 - a. Tank B1
 - b. Tank B6
 - c. Pipe A12-A16
 - d. Jet B1-B10
 - e. Jet B1-B3
- 6) Meriam Model A-275 W.M. 24" Standard Well Manometer. Liquid level tank B26. Reads 0-24" H₂O using red oil - specific gravity 0.827.

- 7) Meriam Model A-275 FF 12" Raised Well Manometer. Specific gravity B26 using Meriam red oil - specific gravity 0.827.
- 8) 4" Model GP-6 Meriam single tube draft gauge for Cell B. Reads 0"-4" H₂O using Meriam red oil - specific gravity 0.827.
- 9) Meriam Model A-275 FF 12" Raised Well Manometer. Pressure differential B26 to Cell B. Read \pm 18" H₂O using Meriam #3 fluid.
- 10) Meriam Model A-953 inclined Manometer. Specific gravity tank B6. Read 4"-8" H₂O.
- 11) 2" Model GP-4 Meriam single tube draft gauge for air flow to tank B6 sparger. Read 0"-2" of H₂O using red oil of specific gravity 0.827.
- 12) Meriam Model A-275 W.M. - 24" Standard Well Manometer. Liquid level tank B6. Read 0-72" H₂O using Meriam #3 fluid.
- 13) Meriam Model A-275 FF 12" Raised Well Manometer. Pressure differential B6 to Cell B. Read \pm 18" H₂O using Meriam #3 fluid.
- 14) Meriam Model A-275 FF 12" Raised Well Manometer. Pressure differential B17 to Cell B. Read \pm 18" H₂O using Meriam #3 fluid.

Panel Board #4B

- 15) 12" Model A-275 FF Meriam Raised Well Manometer. Pressure differential between B2 and Cell B. Read vacuum of 170" H₂O using Hg.
- 16) 6" Model A-275 FF Meriam Raised Well Manometer. Pressure differential between B7 and Cell B. Reads \pm 45" H₂O using mercury.
- 17) 6" Model A-275 FF Meriam Raised Well Manometer. Pressure differential between B9 and Cell B. Reads \pm 45" H₂O using mercury.
- 18) 6" Model A-275 FF Meriam Raised Well Manometer. Pressure differential between B8 and Cell B. Reads \pm 45" H₂O using mercury.
- 19) 12" Model A-275 FF Meriam Raised Well Manometer. Pressure differential between B11 and Cell B. Read vacuum of 170" H₂O using mercury.

- 20) Meriam Model GP-4 Inclined Manometer for measuring pipette air flow. Reads 1" H₂O using red oil specific gravity 0.827. 8" University Speaker.

Panel Board #5

- 1) 12" Meriam Model A-275 FF Raised Well Manometer for liquid level in B10. Reads 0-35" water using Meriam #3 fluid.
- 2) Meriam Model A-275 FF 12" Manometer for specific gravity of B10. Reads 0-10" H₂O using red oil specific gravity 0.827.
- 3) L & N Model "R" Micromax Temperature Indicator. 12 point selector switch. 0°-150°C I. C. couples. Measures following temperatures:
 - a. Tank B3
 - b. Tank B10
 - c. Jet B3-B6B
 - d. Cell B
- 4) 12" Model A-275 FF Meriam Raised Well Manometer. Pressure differential B10 to Cell B. Reads $\pm 18"$ H₂O using Meriam #3 fluid.
- 5) 12" Model A-275 FF Meriam Raised Well Manometer. Pressure differential B3 to Cell B. Reads $\pm 12"$ H₂O using Meriam #3 fluid.
- 6) 12" Model A-275 Meriam Standard Well Manometer. Liquid level of tank B3. Reads 0"-36" of H₂O using Meriam #3 fluid.
- 7) 1" Model GP-2 Meriam single tube draft gauge flow across orifice to B3 sparger. Reads 0"-1" of H₂O using Meriam red oil - specific gravity 0.827.
- 8) 8" Model A-953 Special Meriam Inclined Manometer. Specific gravity for tank B3. Reads 4"-8" H₂O.

Panel Board #6

- 1) L & N Model "S" Micromax Temperature Indicator. 12 point selector switch. 0°-150°C I.C. couples. Measures temperature of head heater, cone heater, off gas and above solution.
- 2) Assembly controls for B19 heater.

- 3) 12" Meriam Model A-275 FF Standard Well Manometer for air flow through orifice to heater for B19. Reads 0"-36" of H₂O using Meriam #3 fluid.
- 4) Assembly
Controls for B19 evaporator.
- 5) 12" Meriam Model A-275 FF Raised Well Manometer using Meriam #3 fluid. B19 to Cell pressure differential. Reads ± 15 " H₂O.
- 6) 2" Meriam Model GP-4 single tube draft gauge for flow through orifice off-gas B19. Reads 0"-2" H₂O using Meriam red oil - specific gravity - 0.827.

APPENDIX

APPENDIX

Drawing List

Dissolver A1

Tank Details
Off-gas Connections

CL-706D-67
CL-706D-21

Tank Arrangement
Slug Counter

CL-706D-103
CL-706D-166

Condenser A2

Details
Supports

CL-706D-68
CL-706D-191

Arrangement

CL-706D-103

Reactor A3

Details

CL-706D-69

Supports

CL-706D-194

Scrubber A4

Details

CL-706D-70

Supports

CL-706D-191

Neutralizer A5

Details
Agitator Assembly

CL-706D-71
CL-706D-129

Arrangement
Motor Reducer
Lubrication

CL-706D-104
CL-706D-150

Hold-up Tank A6

Details

CL-706D-72

Catch Tank A8

Details

CL-706D-100

Supports

CL-706D-193

Precipitator A9

Details
Supports
Arrangement

CL-706D-102
CL-706D-193
CL-706D-177

Agitator Shaft
Assembly
Agitator Assembly
Agitator Drive
Assembly

CL-706D-197
CL-706D-198
CL-706D-199

Condenser A10

Details

CL-706D-109

Supports

CL-706D-194

Catch Tank A11

Details

CL-706D-100

Condenser A12

Details

CL-706D-109

Supports

CL-706D-241

APPENDIX - Drawing List
Page 2

Scrubber A16

Details	CL-706D-70	Supports	CL-706D-191
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Precipitator B1

Details	CL-706D-110	Supports	CL-706D-241
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Pipette B2

Details	ED-373	Supports	D-5
Details	ED-374		

Catch Tank B3

Details	CL-706D-101	Supports	CL-706D-241
Jacket	TD-56		

Precipitator B6

Details	CL-706D-110	Supports	CL-706D-241
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Pipettes B7 and B8

Details	CL-706D-207	Control Tower	CL-706D-268
Details	CL-706D-208	Control Tower	CL-706D-269
Arrangement	CL-706D-206	Golden Horseshoe	ED-394

Pipette B9

Details	CL-706D-217	Sub-Assemblies	CL-706D-218
Details	ED-373	Supports	ED-391
Details	ED-374		

Catch Tank B10

Details	CL-706D-112	Piping	ED-367
Arrangement	ED-366		

Pipette B11

Details	ED-373	Sub-Assemblies	CL-706D-218
Details	ED-374	Supports	ED-391
Details	CL-706D-217		

Electrolytic Cell B12

Details	CL-706D-154	Arrangement-	CL-706D-228
Details	ED-332	Cover	ED-383
Number 1 Cell	ED-269	Supports	CL-706D-139
Platinum Details	CL-706D-155	Electrode Gland	ED-384
Polystyrene Details	CL-706D-156	Thermocouple	D-1
Agitator	CL-706D-227		

Hold-up Tank B17

Details	ED-382	Cover	ED-392
Supports	CL-706D-242	Cover plug	ED-393
Supports	ED-390		

Condenser B18

Details	CL-706D-109	Supports	CL-706D-139
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Evaporator B19

Key Plan	CL-706D-253	Electric Air Heater	CL-706D-257
Head Heater	CL-706D-249	Heater Bracket	CL-706D-255
Head Heater	ED-362	Heater Wiring	CL-706D-258
Elevator and Heater	CL-706D-247	Final Cone Details	1272-3A
Elevator Controls	CL-706D-248	Cone and Collar	ED-295
Elevator and Heater			
Stand	CL-706D-254	Carrier Guides	CL-706D-256
Carrier Dolly Assembly	CL-706D-245	Lifting Yoke	CL-706D-261
Carrier Dolly Details	CL-706D-246	Plug Lift	CL-706D-250
Carrier Dolly Control	CL-706D-252		

Catch Tank B22

Details	D-4
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Funnel Rack B23

Details	ED-387
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Vacuum Pot B24

Details	ED-381	Support	D-4
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Head Tank B26

Details	ED-378	Support	D-3
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Receiver B27

Details	ED-379	Support	D-3
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Slug and Product Handling

Slug Tonge	ED-316	Final Cone Details	1272-3A
Slug Cage	CL-706D-106	Cone and Collar	ED-295
Slug Carrier	CL-706D-211	Platinum Sheath	
Slug Carrier Details	CL-706D-212	for plug	CL-706D-261
Slug Carrier Details	CL-706D-213	Lead Carrier	ED-275
Slug Counter	CL-706D-166	Lifting Yoke	ED-314
Special Carrier	ED-345	Final Product	
Special Carrier	ED-347	Carrier	CL-706D-243
Special Carrier	ED-348	" "	CL-706D-244
Special Carrier Plug	ED-346	Lifting Yoke	CL-706D-251

Slug and Product Handling (Cont'd)

Guard for Shipping
 Carrier CL-706D-267

Process Piping

Cell A Pipe and Jets	CL-706D-114	Cell B Piping Plan	CL-706D-271
Cell A Pipe Plan	CL-706D-115	Cell B Pipe Plan	CL-706D-231
Cell A Pipe Sections	CL-706D-116	Cell B Piping Section	CL-706D-232
Cell A Pipe Sections	CL-706D-117	Cell B Piping Section	CL-706D-233
Cell A Pipe Sections	CL-706D-118	Cell B Piping Section	CL-706D-274
Details Pipes 9, 33, 88	CL-706D-123	M10 Piping	ED-367
Pipe Inside Cell A tanks	CL-706D-153	Pipe Inside Cell B Tank	CL-706D-125
Piping below floor level	CL-706D-10	A6-W9 Line	CL-706D-8

First Floor Make-up Area

Details	ED-234	Details of M1	CL-706D-73
Arrangement and Piping	CL-706D-107	Details of M2	CL-706D-74
Pump Pit	CL-706D-162	Details of M4	CL-706D-75
M10 Pad	CL-706D-172	Details of M6 and M8	CL-706D-76
Exhaust System	CL-706D-157	Details of M10	CL-706D-63
Measuring Rods	CL-706D-136		

Third Floor Make-up Area

Details	ED-234	Lead Details of T4	CL-706D-184
Head Tank Platform	CL-706D-148	Details of T6	CL-706D-64
Piping	CL-706D-108	Details of T7	CL-706D-79
Details of T1 and T2	CL-706D-61	Details of T8 and T9	CL-706D-65
Details of T3, T4, T5	CL-706D-78		

Sampling Equipment

Standard Sampler	CL-706D-179	Capillary Samplers	CL-706D-209
Standard Sampler Piping	CL-706D-181	Capillary Sampler,	
Sampler Shield Liner	CL-706D-180	details	CL-706D-210
Standard Sampler,		15 lb. sample Carrier	CL-706D-187
details	CL-706D-182	15 lb. sample Carrier	ED-370
Sample Container	ED-181	5 lb. sample Carrier	CL-706D-188
Test Tube Clamp	ED-364		

Panel Boards

PB1 Piping	CL-706D-119	PB2 Piping	CL-706D-122
PB1 Steel	CL-706D-120	PB2 Steel	CL-706D-121
PB1 Typical Installation	CL-706D-126	PB2 Typical Installation	CL-706D-123
PB3 Arrangement	CL-706D-152		

APPENDIX -- Drawing List
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Panel Boards (Cont'd)

PB4A Arrangement	CL-706D-153	PB4B Arrangement	CL-706D-236
PB4A Steel	CL-706D-237	PB4B Steel	CL-706D-186
PB4A Typical Installation	CL-706D-190		
PB5 Arrangement	CL-706D-235	PB6 Arrangement	CL-706D-219
PB5 Steel	CL-706D-238	PB6 Steel	CL-706D-214
Head Tank Instruments	CL-706D-262		

Steel Work

For Vessels or Panel Boards, see item in question.

Monorail Layout	CL-706D-24	Cell A Channels	CL-706D-192
Monorail Supports	CL-706D-163	Cell B Channels	CL-706D-195
Monorail Supports	CL-706D-174		
Monorail Supports	CL-706D-176		

Off-gas Ventilation

Fan House	CL-706D-20	Concrete Exhaust Ducts	CL-706D-17
Blower House	CL-706D-276	Cell Air Outlet	CL-706D-58
Blower House Piping	CL-706D-276	Off-gas from Cells	CL-706D-277
Blower House Wiring	CL-706D-132	Cell to Stack	CL-706D-260
Fan House Arrangement	CL-706D-98	Off-gas to 205	CL-706D-21
Stack Monitor	CL-706D-173	Operating Space	
Duct and Stack	CL-706D-28	Ventilation	CL-706D-80
Cell Ducts	CL-706D-86	Hood Ventilation	CL-706D-142
Cell Exhaust	CL-706D-93	Equipment Decontamination Room Exhaust	CL-706D-270
Cell Exhaust Louvers	CL-706D-175	Make-up Room Exhaust	CL-706D-157

Process Electrical Equipment

Thermocouples in Cell A	CL-706D-220	First Floor Instruments	CL-706D-37
Thermocouples in Cell B	CL-706D-223	Second Floor Instruments	CL-706D-42
Thermocouples to PB1	CL-706D-221	Third Floor Instruments	CL-706D-43
Thermocouples to PB2	CL-706D-222	Symbols and Details	CL-706D-41
Thermocouples to PB4	CL-706D-224	Micromax Panel Board	CL-706D-229
Thermocouples to PB5	CL-706D-225	B19 air heater	CL-706D-258
Thermocouples to PB6	CL-706D-226	B19 air heater	CL-706D-257
Thermocouple Junction Box	ED-389	Schematic Diagrams	CL-706D-263
Stack Monitor	CL-706D-173	Microphone Box	ED-386
		Slug Counter	CL-706D-166

Cubicles

Study Drawing	D-7	Steel Work	E-582
Arrangement	E-581	Steel Work	E-595
Concrete Pad	E-580	Top Pan	E-597
Lead Brick Work	E-609		

Cells I, and III

Liners	E-592	Glass Equipment	ED-389
Door	E-589	Glassware Wall Supports	E-612
Specific Viewer Housing	E-584	Reactor Installation	E-611
Lighting	E-585	Hood Supports	E-616
Off-gas Hoods	ED-396	Transfer Vessel Supports	D-618
Reactor Locator	C-614	Ball Joint Clamp	D-619

Cell II

Liner	E-593	Hasteloy Valve	ED-57
Door	E-590	Valve Handle	ED-361
Lighting	E-583	Valve Supports	E-604

Cell IV

Liner	E-596	Piping and Glassware	E-613
Door	E-588	Crud Filter	A-617
Lighting	E-598	Ball Joint Clamp	ED-388
Specific Viewer Housing	E-584	Unit Clamp	D-6
Clamp Tongs	E-620	Assembly to Cell III	ED-395

Services

Outside Electric Line	CL-706D-2	Steam and Air to Bldg.	CL-706D-11
Transformer	CL-706D-6	Drain Piping	CL-706D-124
Power, first floor	CL-706D-37	Pipe below floor level	CL-706D-10
Power, second floor	CL-706D-42	Water Still Platform	CL-706D-144
Lights, first floor	CL-706D-38	Telephone Cable	CL-706D-7
Power, third floor	CL-706D-45	Piping First Floor	CL-706D-19
Lights, second floor	CL-706D-39	Piping Second Floor	CL-706D-49
Lights, third floor	CL-706D-40	Piping Third Floor	CL-706D-60
Electrical Symbols	CL-706D-41	Piping, schematic	CL-706D-61
Motor Wiring	CL-706D-44	Piping, diagramatic	CL-706D-62
Schematic Wiring	CL-706D-184	First Floor heating	CL-706D-45
Cell Lock Wiring	CL-706D-266	Second Floor heating	CL-706D-46
Generator House	CL-706D-131	Third Floor heating	CL-706D-47
Generator	CL-706D-132	Heating, details	CL-706D-48

Building 706D

Proposed Bldg.	CL-706D-1	Trusses and Supports	CL-706D-29
First Floor Plan	CL-706D-9	Trusses and Supports	CL-706D-30
Second Floor Plan	CL-706D-12	Trusses and Supports	CL-706D-31
Third Floor Plan	CL-706D-18	Building Sections	CL-706D-54

Building 706D (Cont'd)

Framing Plans	CL-706D-22	Building Sections	CL-706D-65
Framing Plans	CL-706D-23	Building Elevation	CL-706D-66
Framing Sections	CL-706D-26	Grading Plans	CL-706D-196
Framing Sections	CL-706D-27	Composite Map	CL-706D-6
Stairways	CL-706D-56	Locker Room	CL-706D-141
Stairways	CL-706D-134	Personal Decontamination	CL-706D-143
Outside Stairs	CL-706D-200	Room	CL-706D-145
Foundation Plan	CL-706D-3	Clothes and Janitor Room	CL-706D-145
Sub-Station Foundation	CL-706D-4	Doors and Room Finish	CL-706D-57
Foundation Sections	CL-706D-13	Roof Plan	CL-706D-62
Analytical Lab.	CL-706D-15	Roof Gutters	E-624
Anchors	CL-706D-14	Monitor Room	CL-706D-25

Cell Structure

Cell Plans	CL-706D-83	Door plate and burning	
Cell Structure	CL-706D-84	strips	CL-706D-52
Cell Structure	CL-706D-85	Inserts and Sleeves	
Cell Structure	CL-706D-86	(Roof slab)	CL-706D-88
Cell Structure	CL-706D-87	Inserts and Sleeves	
Cell Foundations	CL-706D-16	(Cell A)	CL-706D-89
Cell Structure Inserts	CL-706D-59	Inserts and Sleeves	
Concrete Plugs	CL-706D-91	(Cell B)	CL-706D-90
Periscope Sleeves	CL-706D-94	Pipe in Cell Walls	CL-706D-92
Labyrinths	CL-706D-95	Concrete roof Plugs	CL-706D-87
West Wall (Cell B)	ED-3725	Cell B Chimney	CL-706D-96
Top of Cell B	CL-706D-234	False Floor Cell B Roof	CL-706D-216

Miscellaneous

Isolation and		Special Lab. Table	CL-706D-77
Concentration	ED-245	Special Lab. Table	CL-706D-82
Metal Separation	ED-233F-	Special Lab. Table	CL-706D-140
Cell B Flowsheet	ED-380	Special Lab. Table	CL-706D-161
Cl. no. 2 Steam Jet	CL-706D-150	Special Sink	CL-706D-33
Cl. no. 3 Steam Jet	CL-706D-151	Mandrel for Plug Sleeves	CL-706D-80
Cl. no. 5 Steam Jet	CL-706D-159	Test Plugs	CL-706D-165
Pipe Sleeves	CL-706D-34	Specific Viewer Housing	CL-706D-215
Linoleum Installation	CL-706D-146	Thermocouple Wells	CL-706D-127
Special Plug (Cell B)	CL-706D-239	Concrete Plugs	CL-706D-178
Tank and Jacket Cones	CL-706D-259	Condensate Pots	ED-376
Tong Development Study	TD-855	Tong Development Study	TD-695

Morgue

B15 Supports	CL-706D-139	Hastelloy Valve	CL-706D-278
B5 Supports	CL-706D-242	Semi-ball Joint	ED-369
Flowmeter alarm	CL-706D-265	Glassware Rack	ED-360
B5 Details	CL-706D-240	Glass Reactor	ED-350

Morgue (Cont'd)

5 inch Centrifuge	CL-706D-135	Centrifuge Drive	CL-706D-170
5 inch Centrifuge	CL-706D-136	Centrifuge Drive	CL-706D-171
5 inch Centrifuge	CL-706D-137	#4 Centrifuge	ED-177-DA
5 inch Centrifuge	CL-706D-138	#4 Centrifuge	ED-179
5 inch Centrifuge	ED-266	#4 Centrifuge	ED-180
B2 & B5 Centrifuge	CL-706D-168	Adjustable Jet #1	ED-231
B2 & B15 Centrifuge	CL-706D-169	Polarograph	ED-333
B2 & B15 Shimmer	CL-706D-204	Polarograph	ED-334
B2 & B15 Arrangement	CL-706D-205		

JET LIST

Jet	P.B.	No.	Cl. No.	SUCTION			Type	DISCHARGE			Mat'l.	STEAM	
				Size Inches	No.	Mat'l.	Suction End	Thermo Indicator	Size Inches	No.		Size Inches	Mat'l.
AD-A5	3		1	1	8	25-12	Strainer		1/2	190	18-8	3/8	18-8
AS-A5	3	63617	1	1	192	18-8	"		1	63	18-8	1/2	18-8
AS-A7L1	3	63617	1	1	194	18-8	"		1	177	18-8	1/2	18-8
AI-A7L1	1	84813	1	1	194	25-12	1		1	14	25-12	1/2	18-8
A5-A6	1	84820	1	1	51	25-12	1		1	83	18-8	1/2	18-8
A5-A8	2	150:14	2	3/8	44	25-12	1		1	45	25-12	1/2	18-8
A6-A79	1		1	2	78	18-8	1		1/2			1/4	18-8
A6-A7L1	1	84820	1	1	184	18-8	1		1	61	18-8	1/2	18-8
AI-A6	1	63617	1	1	30	25-12	1		1	86	18-8	1/2	18-8
AI-A9A	1	48813	1	1	23	25-12	1		1	21	25-12	1/2	18-8
AI-A9B	1	150:23	1	1	26	25-12	1		1/2	24	25-12	1/4	18-8
AI-A11	1	84777	1	1	27	25-12	1		1	268	25-12	1/2	18-8
A5-A7L1	1	84777	1	1	173	25-12	1		1	49	18-8	1/2	18-8
A5-A5A	1	84777	1	1	66	25-12	1	T.C.	3/4	52	25-12	1/2	18-8
A5-A5B	1	63617	1	1	67	25-12	1	T.C.	3/4	54	25-12	1/2	18-8
AG-A5	1	150:16	2	1	72	18-8	1		1/2	61	18-8	1/4	18-8
AG-A6	1	84813	1	1	84	18-8	1		3/4	73	18-8	1/2	18-8
A8-A5DA	1	150:1	3	1/4	135	25-12	4		3/8	135	25-12	1/4	18-8
A8-A5B	1	150:8	2	3/8	132	25-12	1		1/2	131	25-12	1/4	18-8
A8-A8	2	150:12	2	3/8	127	25-12	1		1/2	126	25-12	1/4	18-8
A8-A9	2	150:12	2	3/8	122	25-12	1		1/2	129	25-12	1/4	18-8
A8-A11	2	84820	1	3/8	265	25-12	1		1	266	25-12	1/2	18-8
AI1-A1	2	?	2	3/8	255	25-12	1		1/2	256	25-12	1/4	18-8
A9-A8DA	2	Hanford #2	1	3/8	157	25-12	4 with slot 3/32	T.C.	1	154	25-12	1/2	18-8
A9-A8DB	2	150:19	2	3/8	143	25-12	"		1/2	158	25-12	1/4	18-8
A9-A8C	2	150:18	2	3/8	144	25-12	4		1/2	160	25-12	1/4	18-8
A9-D2CB	2	150:17	2	3/8	145	25-12	5		1/2	168	25-12	1/4	18-8
A9-B1DC	2	150:21	2	3/8	149	25-12	4		1/2	170	25-12	1/4	18-8
A9-B1DD	2		2	1/8	148	25-12	5		1/2	165	25-12	1/4	18-8
A9-B12	2	150:20	2	3/8	146	25-12	5		1/2	164	25-12	1/4	18-8
A9-B26A	2	2	2	3/8	147	25-12	5		1/2	164	25-12	1/4	18-8
AI1-A5A	2	84815	1	1/2	262	25-12	1		1	263	25-12	1/2	18-8
		84877											
AI1-A8	2	84820	2	3/8	275	25-12	1		1/2	276	25-12	1/4	18-8
AI1-A9	2	84815	1	1/2	258	25-12	1		1	259	25-12	1/2	18-8

JET LIST (Cont'd)

BS-111	3	84816	1	1	500	25-12	Strainer	1	661	25-12	1/2	502	18-8
BS-A6B	3	84777	2	1/2	501	25-12	"	1/2	662	25-12	1/4	503	18-8
ALL-A5DB	2	84777	2	3/8	261	S.S.	1	1/2	273	S.S.	1/4	274	S.S.
B1-B3D	4A	151:22	3	1/8	531	25-12	4	3/8	538	25-12	1/4	523	18-8
B1-B6	4A	150:13	2	1/4	530	25-12	4	1/2	539	25-12	1/4	524	18-8
B1-B10	4A	150:11	2	1/4	533	25-12	5	1/2	725	25-12	1/4	526	18-8
B1-B12	4A	150:2	3	1/4	534	25-12	5	3/8	542	25-12	1/4	527	18-8
B1-B26	4A	150:9	2	1/4	535	25-12	5	1/2	726	25-12	1/4	528	18-8
B3-B1	5	150:5	3	1/4	566	25-12	5	3/8	567	25-12	1/4	553	18-8
B3-B6	5	150:8	3	1/4	565	25-12	5	3/8	569	25-12	1/4	555	18-8
B3-B10A	5	150:7	2	3/8	560	25-12	6	1/2	728	25-12	1/4	554	18-8
B3-B10B	5	150:13	2	3/8	563	25-12	5	1/2	727	25-12	1/4	557	18-8
B3-B12	5	150:16	3	1/4	561	25-12	5	3/8	573	25-12	1/4	559	18-8
B3-B1	4A	150:24	2	1/4	622	25-12	4	1/2	587	25-12	1/4	619	18-8
B3-B3A	4A	51:23	3	1/4	621	25-12	4	3/8	624	25-12	1/4	618	25-12
B3-B3DB	4A	151:17	3	1/8	620	25-12	4	3/8	623	25-12	1/4	617	25-12
B10-A5A	5	150:63	2	3/8	721	25-12	cut 45°L and placed on bottom	1/2	722	25-12	1/4	708	18-8
B10-A5B	5	150:8	2	3/8	719	25-12	"	1/2	572	25-12	1/4	707	18-8
B10-A9	5	150:80	2	3/8	723	25-12	"	1/2	724	25-12	1/4	709	18-8
B10-B3	5	150:30	2	3/8	717	25-12	"	1/2	718	25-12	1/4	706	18-8
C20-322	4A		2	3/8	918	25-12	slightly beveled	1/2	919	25-12	1/4	525	18-8
C21-BE2	4A		2	3/8	920	25-12	cut 45°L	1/2	921	25-12	1/4	522	18-8
D22-D10	4A	150	2	3/8	586	25-12		1/2	588	25-12	1/4	584	18-8
Pit to Drain		29-11-129		1							3/4		
Catch Tank													
to 11-11													
ALL-A6D	2	Handed	2	2		25-12		1/2		25-12	1/4		25-12
		53	1	3/8	408	25-12		1	409	25-12	1/2	410	25-12

Cell A Jet suction end details from drawing CL-706D-158.

Cell B Jet suction end details from drawing CL-706D-271.